TEXT-BOOKS OF SOCIAL BIOLOGY
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THE MEASUREMENT OF POPULATION GROWTH

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The following are in preparation :

BIOLOGY IN MODERN LIFE. By B. WOOLF.

THE STUDY OF BEHAVIOUR. By J. Z. YOUNG.

THE MEASUREMENT OF POPULATION GROWTH

METHODS AND RESULTS

BY

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LONDON

SIDGWICK & JACKSON, LTD.

1935

PRINTED BY
WILLIAM CLOWES AND SONS, LIMITED
LONDON AND BECCLES.

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THE MEASUREMENT OF POPULATION GROWTH

INTRODUCTION

MANKIND increases through births and decreases through deaths. The number of people living at any moment is equal to the difference between the number born up to that moment and the number deceased up to that moment. If we knew these numbers we should also know the population of the earth. Unfortunately we do not know them.

The upper limit of fertility (actual production of children) is determined by fecundity (child-bearing capacity); it would be reached if all females gave birth to as many children as they possibly could. The lower limit is zero; it would be reached if a general birth strike was 100 per cent successful.

The upper limit of mortality is represented by the number of existing people, since all these people may die at once. The lower limit is above zero, since human beings are not immortal; but it is impossible to say where the lower limit actually lies.

The full effect of fecundity would be realized if all females, throughout their entire child-bearing period, had sexual intercourse with procreative men and did nothing to prevent conception nor to procure abortion. Since those conditions are never and nowhere fulfilled, fertility always and everywhere lags behind fecundity. But there have been, and there still are, in every country individual females who from the beginning till the end of their child-bearing period are married to procreative men, and who neither through abstinence nor through contraceptive devices or deliberate abortions restrict fertility. There are also communities where such females constitute a vast majority. In the seventeenth century this was

true of the French Canadian women who, on account of the great scarcity of females, mostly married very young and usually remarried quickly when their husbands died while they were still in child-bearing age. But even granted that such women generally had as many children as they possibly could—and the available figures tend to prove that—there were some women, particularly nuns, who practised complete abstinence.

Till a few decades ago, abstinence of unmarried females was generally considered the most decisive factor in reducing fertility as compared with fecundity. There were even people who apparently believed that for married women fertility fully corresponded to fecundity. We may quote in this connection Messance (1766), who considered it physically impossible that tax-exemptions granted by Louis XIV to the fathers of numerous children could lead to an increase of births : [1]

> . . . the fertility of the marriages depends on causes absolutely independent of the wish even of those who can alone contribute to it, and is for this reason above all laws made by men.

There were, to be sure, contemporaries of and even earlier writers than Messance who, in discussing population growth, pointed to practices preventing conception and procuring abortion,[2] and also to differential fertility between urban and rural dwellers, between the well-to-do and the poor. But they referred merely to birth control of unmarried women, and they did not intimate that differential fertility of married women was due to any deliberate action, but rather to impotence of the husband, barrenness of the wife, the abuse of spirituous liquors, and luxurious and unwholesome manner

[1] Messance, *Recherches sur la population des Généralités d'Auvergne, de Lyon, de Rouen, et de quelques provinces et villes du Royaume*, etc., p. 143, Paris, 1766.

[2] One year after the publication of Messance's book, Thomas Short complained that " so many wicked Arts are daily used to prevent Conception and cause Abortion," and proposed : " Such as are proved guilty of unnatural Gratifications of their Inclination, or use Arts, Instruments, or Methods to prevent Conception or cause Abortion, let all such suffer according to excellent Laws in that Case to be provided, and the Instrument Maker be punished or hanged with the Criminals." See *A Comparative History of the Increase and Decrease of Mankind in England, and several Countries Abroad*, pp. 27, 29–30, London, 1767.

of living. To encourage matrimony, especially early marriage, and to hinder licentiousness of married people seemed the best and practically the only means of promoting fertility.[1]

In any case, birth control of married women did not affect fertility to a very considerable extent. It is, therefore, safe to assume that the ratio of fertility to fecundity among married women in former times was fairly constant on the whole. Fecundity itself, of course, changed—it dropped, say, in case of a famine—but such changes were seldom permanent, and, if permanent, were seldom considerable. Mortality, on the other hand, varied enormously. It was therefore the decisive factor in determining population growth.[2]

To-day the situation is quite different in all countries of western civilization. With the ever-increasing spread of birth control the gap between fecundity and fertility has been widened more and more. Mortality, on the other hand, no longer fluctuates extensively. The decisive factor in determining present population growth, therefore, is fertility.

This book, then, is primarily concerned with fertility. Mortality will be discussed only in so far as it counteracts the results of fertility. Immigration and emigration will not be considered at all.

[1] See Kuczynski, "British Demographers' Opinions on Fertility, 1660–1760," *Annals of Eugenics*, vol. vi, 1935. Birth control through married women apparently did not attract the attention of demographers until the last quarter of the eighteenth century. The first who discussed it was probably Moheau (*Recherches et considérations sur la population de la France*, vol. i, pp. 101–102, Paris, 1778).

[2] The fact that fertility was much more constant than mortality was perhaps first realized by Sir William Petty (1682), who stated: "That the *Births* are the best way (till the Accompts of the people shall be purposely taken) whereby to judge of the Increase and Decrease of People, that of *Burials* being subject to more Contingencies and variety of Causes" (see *Observations upon the Dublin-Bills of Mortality, MDCLXXXI, and the State of that City* by the Observator on the London Bills of Mortality, p. 3, London, 1683). From the fact that births were more numerous in Dublin in 1678–1680 than in 1674 he draws the conclusion that the population must have increased in the same proportion: "For other causes of this difference in Births, are very occult and uncertain" (*ibid.*, p. 4). Many writers in the subsequent 150 years emphasized the constancy of the number of births. See, for instance, William Godwin (*On Population*, etc., *Being an Answer to Mr. Malthus's Essay on that subject*, p. 172, London, 1820): ". . . give me the number of females at twenty in any year in the community, and I will tell you the number of births."

The investigator of fertility is confronted with two tasks. He must appraise the accuracy of the available statistical data in order to avoid using inadequate statistics, and he must relate the various statistical data to each other in such a manner that they convey a true picture of fertility. The object of the first chapter of this book is to facilitate a judicious appraisal of the statistics of births. It shows how the investigator may test the completeness and the accuracy of statistical data, and how, in particular, he should tackle the problem of legitimate and illegitimate fertility which is so much obscured by the considerable proportion of legitimate children conceived before marriage. The subsequent chapters are devoted to an analysis of the principal methods used for measuring fertility, mortality, and population growth, and of the results obtained by such measurement.

Many methods have been and are still used for measuring fertility, mortality, and the balance of births and deaths. In every case the basic data are either (1) vital statistics, or (2) census data, or (3) vital statistics and census data combined. The founder of population statistics, John Graunt (1662), used vital statistics exclusively because at his time no census was taken in England. American statisticians, all through the nineteenth century, had to resort to census data because births and deaths were not properly registered. Wherever both vital statistics and census data are available it has become the universal practice to measure mortality by relating deaths to population. But fertility and population growth are still to-day frequently measured by the earlier methods, *i.e.* the exclusive use of either vital statistics or census data, and without due regard to the age composition of the population.

Why is it that fertility, contrary to mortality, is still generally measured by inadequate methods? The main reason is: Interest in mortality has been keener than interest in fertility. The business of insurance companies and policies of public health depend on assessing mortality. The fact that mortality was the decisive factor in determining population growth till the end of the nineteenth century has also been a strong

incentive to the perfection of the methods for measuring mortality. The basic death data for an accurate measurement of mortality (deaths by age) have been regularly published for every civilized country. The fact that nowadays fertility is the decisive factor in determining population growth has had a marked influence in shaping the statistical work in newer countries, but some of the older countries still cling to the antiquated methods of measuring fertility, and do not even provide the basic birth data for an accurate measurement of fertility (births by age of mother). In the report of the Registrar-General for England and Wales for 1926, births were still classified only by sex and legitimacy, just as in 1842, and the only progress achieved since then is a similar classification for still-births. This lack of adequate data certainly fosters the use of inadequate methods for measuring fertility. But even where adequate birth data are available, the best use is not always made of them because the analysis of birth statistics, unlike the analysis of death statistics, is not yet considered a professional duty involving great responsibilities. If this state of affairs persists the bulk of this book will be of interest only to a few scholars. But if the point of view that fertility deserves as careful a treatment as mortality gains ground, an appraisal of the methods of measuring fertility may prove to be of some practical use.

Results of the best methods of measuring fertility, mortality, and population growth are to be found in Chapters IV, V, and VI. They cover Europe, Australia, New Zealand, and in some cases also Canada and the United States. Our guiding principle was to include only countries and periods for which the official statistics are fairly complete.[1] Special

[1] In view of this restriction no attempt has been made to revise, for instance, the official birth data even when an estimate of the minimum number of omissions was feasible. We thus give here 3·176 as the gross reproduction rate for Bulgaria, 1901–1905 (computed from the official birth figures), although we feel confident that the rate was actually at least 3·24 (see Kuczynski, *The Balance of Births and Deaths*, vol. ii, p. 33, Washington, 1931).

In some cases where official data are lacking we have resorted to estimates. This was necessary, for instance, in order to obtain the total number of births and deaths in Western and Northern Europe (Appendix, Tables II and VI).

stress has been laid upon showing the trend for the last sixty years until 1934.

The book is not concerned with the causes and consequences of decreasing fertility. This subject has been treated by another staff member of the Department of Social Biology, Dr. Enid Charles, in her recent volume *The Twilight of Parenthood.*

CHAPTER I

THE APPRAISAL OF BIRTH STATISTICS

1. Number of Births

Birth statistics, as a rule, are based on birth registration, and the accuracy of such statistics depends in the first place on the completeness of registration. Birth registration can never be as complete as, for instance, marriage registration, since in most countries marriage becomes valid only through registration, while births (and deaths) do not depend on registration and actually are not registered in more or less numerous cases. The student of birth statistics usually does not doubt the completeness of registration, or, if he is diffident, feels helpless. It seems, therefore, useful to indicate some tests which the investigator may and should apply whenever he has not good reasons to assume that birth registration will be fairly complete.

1. He should compare the numbers of births for several consecutive years. If he is interested in Cuba or Mexico, he will find the following figures : [1]

Year	Cuba	Mexico
1923	55,581	470,723
1924	57,011	459,894
1925	63,606	503,531
1926	187,881	483,339
1927	59,680	480,752
1928	60,231	517,064
1929	60,441	634,897
1930	150,888	819,814
1931	99,438	755,282
1932	65,706	734,436
1933	66,922	—

[1] See *Statistical Year-Book of the League of Nations*, 1931–32, p. 49; 1933–34, p. 47; Istituto Centrale di Statistica del Regno d'Italia, *Notiziario demografico*, 1935, p. 77.

In both countries the differences from year to year are in part very large and, therefore, should arouse suspicion. But each case is different.

The Cuban figures should be discarded without further examination, since it is inconceivable that the number of births in one year (1926) could be three times as high as in each of the three preceding *and* the three following years. The birth figures of Cuba, which were much more accurate under the Spanish régime, have for many years been extremely erratic. Every few years the Cuban Government issues a new decree inviting the population to register births, with the result that ten thousands of parents who had neglected to have their children registered do so. But registration of newly-born children remains utterly inadequate.

The Mexican figures for 1923–1928 should also be discarded without further examination, because the gradual rise in 1929 and 1930 clearly indicates that registration was very incomplete before 1929. The figure for 1929 should also be rejected as incomplete because the figures in all subsequent years were considerably higher. The very high figure for 1930 (820,000 births in a population of 16,500,000) and the heavy drop from 1930 to 1931 would seem to indicate that numerous births occurring before 1930 have been registered in that year. The figures for 1931 and 1932 may be accepted as fairly accurate. The example of Mexico is interesting also from another standpoint. Before the figures for 1929 were known, the figures for 1923–1928 could be accepted as fairly accurate. Three years ago the International Statistical Institute, in publishing these figures, stated: [1] "The figures are not absolutely accurate because in the Federal District there is no obligation to report the births." And yet probably one-third of all the births in the country had not been registered, a fact which certainly cannot be explained by inadequate registration in the Federal District alone, since this district comprised only 7 per cent of the total population.

2. The student should ascertain the ratio of births to

[1] *Aperçu de la démographie des divers pays du monde* 1931, p. 128, The Hague, 1932.

population. He may find as births for Albania in 1922–1929: 11,414; 7,936; 9,725; 9,770; 12,105; 13,148; 12,509; and 12,429.[1] If the population of Albania were 300,000 or 400,000, none of the yearly birth figures taken by itself would appear to be impossibly low, and it would be necessary to ascertain whether a war or a famine may have reduced the number of births in 1923–1925. But since the population of Albania was 900,000 or 1,000,000, it is evident that only a small fraction of the actual number of births was reported.

3. He should ascertain the ratio of male to female births. If this ratio is higher than 1·15 : 1, it is safe to assume that registration of girls is incomplete. This may be due to the fact that the laws on military service make the registration of boys more important, or to the fact that for some other reason many fathers do not take the trouble of covering the sometimes very long distance from their dwelling to the registration office in order to have a girl registered. In the latter case, registration of boys is also likely to be deficient, although less so than that of girls.

4. The student should compare the number of births in the year preceding a census with the number of children under one year ascertained at the census. The number of births ought to be higher because the census includes only those children who are still living. If, therefore, the number of births is lower, birth registration is to be considered inadequate. The 1929–30 birth figures of Oklahoma and of Tennessee, 40,930 and 51,881,[2] should thus be rejected without further examination because the numbers of children under one year ascertained at the census of 1 April, 1930, were 51,634 and 56,335 respectively.[3] When the number of children under one year is not higher than that of children between one and two, or when for some other reason the accuracy of the age data given by the population seems doubt-

[1] See *ibid.*, p. 114.

[2] Births from 1 April, 1929 to 31 March, 1930; see United States Department of Commerce, Bureau of the Census, *Introduction to the Vital Statistics of the United States, 1900 to 1930*, by Walter F. Willcox, p. 80, Washington, 1933.

[3] See *Fifteenth Census, Reports on Population*, vol. ii, pp. 672–673.

ful, it is advisable to compare the number of births in the five years preceding the census with the number of children under five years ascertained at the census. This may be illustrated by the birth figures for New Zealand Maoris in the intercensal period 1921–1926. The total number of such births was 6,899, while the children under five ascertained at the census of 1926 was not less than 10,380.[1] It would thus appear that birth registration of Maori children was most inadequate.[2]

Of course, we should be careful not to conclude from a plausible ratio of the number of births to the number of children that registration is complete. Both birth registration and the enumeration of children may be incomplete to a similar extent. A striking example of this kind is furnished by the United States. The number of children under one year ascertained on 1 April, 1930, was 2,190,791,[3] of whom 2,054,833 lived in the Birth Registration Area.[4] The total number of live-born recorded in 1929–30 in the Birth Registration Area was 2,187,551.[5] The ratio of children to births (0·94 : 1) is approximately what one would expect, since 93 per cent of the newly-born in the United States survive the first year of age, and since most of the children under one year ascertained at a census have been exposed to death much less than one year. But we saw, on the other hand, that birth registra-

[1] See Dominion of New Zealand, *Population Census*, 1926, vol. xiv, pp. 3, 20.

[2] Such a check was evidently not made by the New Zealand Government Statistician, who, in discussing the recorded births for 1925–1927, stated: "The number of Maori births recorded in 1925 was much higher than in any previous year. It is impossible to say to what extent this is due to births which occurred in previous years not being registered until 1925, but the 1926 and 1927 figures may be regarded as normal" (*New Zealand Official Year-Book*, 1929, p. 128). The 1716 Maoris births recorded in 1925 constituted only perhaps two-thirds of the births which actually occurred in that year. The number of registered births in 1926 and 1927—1,536 and 1,495—lagged still more behind the truth. Registration was less deficient in the following four years, when 1,845, 2,216, 2,124, and 2,312 births were reported. But it apparently became satisfactory only in 1932 or 1933, when 2,745 and 2,948 births were registered.

[3] See *Fifteenth Census, Reports on Population*, vol. ii, p. 576.

[4] The Birth Registration Area included all states except South Dakota and Texas. The numbers of children under one year in these two states were 13,862 and 122,096 respectively (see *ibid.*, pp. 672–673).

[5] Computed from *Introduction to the Vital Statistics of the United States, 1900 to 1930*, p. 80.

tion was utterly deficient in Oklahoma and Tennessee, and a comparison of the births of 1929–30 with the children under one year enumerated on 1 April, 1930, shows that birth registration must have been inadequate in a number of other states such as Arizona, Arkansas, Colorado, Georgia, Idaho, Iowa, Kansas, Kentucky, Louisiana, Nevada, North Dakota, West Virginia. If, notwithstanding such deficiencies in registration, the ratio of births to children looks plausible, it is due to the fact that the enumeration of children was likewise inadequate and, for the country as a whole, at least as inadequate as birth registration. But conditions vary greatly from state to state. In Oklahoma, Tennessee, Colorado, etc., birth registration was much more deficient than enumeration of children, however deficient the latter may have been. In other states like New York, where 217,628 births were registered in 1929–30, while no more than 185,734 children under one year were enumerated on 1 April, 1930, birth registration evidently was much less deficient than enumeration of children, and the same is true, for instance, of Massachusetts and Pennsylvania.

5. If none of these tests furnishes proof of incomplete birth registration in the state as a whole, the investigator should apply them to geographical subdivisions, or to special groups such as religious minorities. A few examples may illustrate the results of doing so.

In the 50 provinces of European Russia, according to the census of 28 January, 1897, the Jewish children under one year consisted of 58,283 boys and 55,890 girls ; the number of Jewish births registered from 1 February, 1896, until 1 February, 1897, comprised 70,386 boys and 52,711 girls.[1] The ratio of male to female children at the census seems quite plausible. The same is true of the ratio of boys born to boys living. But the ratios of female births to male births, and of female births to female children are far too low, and cast grave doubt upon the adequacy of birth registration for Jewish girls.

[1] See Kuczynski, *The Balance of Births and Deaths*, vol. ii, p. 99.

In Serbia, 12 Mahometan births were reported for 1891, 87 for 1892, 173 for 1893, and an average of 166 for 1896–1905. Since the number of Mahometans counted at the censuses of 1890, 1895, and 1900 averaged 15,308, there is not the least doubt that only a small fraction of the actual births has all the time been included in the statistics.[1]

For most provinces of the Argentine the ratio of male to female births does not give rise to any particular suspicion. But in the Provincia de la Rioja the ratio in each year from 1917 to 1923 exceeded 1·15 : 1.[2]

It is, however, one thing to ascertain whether or not birth statistics are seriously deficient, and quite another thing to estimate the degree of deficiency. We should distrust the accuracy of birth statistics in all cases where obligatory birth registration has not existed for a long period, and moreover in all cases where the contacts of the authorities with the people are likely to be loose, either because the country is sparsely settled, or on account of racial differences. But we should also distrust statements about the degree of deficiency of birth registration. An illustration of this is provided by the results of official computations of unregistered births in England and Wales, in the 39½ years from 1 July, 1837 (when civil registration began), until 1 January, 1877 (two years after birth registration had become obligatory). The best known statement, usually referred to in text-books, was made by William Farr in a report dated 30 March, 1878 : [3]

> Looking back from the first complete year of registration to the last, the annual births were 463,787 in 1838 and 887,968 in 1876 ; and the new births actually recorded from 1st July 1837 on the national registers were 26,129,906. There were in the first year 30·3 births registered to every 1,000 inhabitants, in the last year 36·6 ; and after allowing for any natural increase of the rate in the interval, or any deficiency of registration in the last year of all, I am inclined to think the actual birth-rate of living children was

[1] See *ibid.*, p. 121.

[2] See *La Población y el Movimiento Demográfico de la República Argentina en el Período* 1910–1925, pp. 67–71.

[3] *Thirty-Ninth Annual Report of the Registrar-General of Births, Deaths, and Marriages in England* (*Abstracts of* 1876), p. v.

36 per 1,000 during the 39½ years of civil registration. At this rate besides the 26,129,906 births registered therefore 1,441,603 births remained unregistered, or about 5 in 100.

This sweeping statement is the more surprising as Farr, in 1874, had published a much more conservative estimate of the gaps in the registration of births : [1]

> The precise extent of the deficiency cannot be determined ; but I am disposed to believe that the annual deficiency in the last ten years does not exceed the estimate in the last Census Report, and that was 13,614 out of 763,623. The probable annual deficiency in the ten years 1841–50 was 38,036, in the next ten years 19,323, and in the last ten years, as has been already shown, 13,614. The deficiency thus rapidly declined : calculated on 1,000 births occurring, it was in the three decades, 65 in the first, 29 in the second, and 18 in the third.

The table in the Census Report, which was likewise prepared by Farr, shows that in 1841–1870 the number of registered births was 19,460,482, the number of " calculated " births (births " estimated by the English Life Table from the number of children under ten years of age ") 20,170,215, and the " probable deficiency of registered births " 709,733,[2] or 3·5 per cent. Since registration was certainly more incomplete in 1837–1840, but more complete in 1871–1876 than in 1841–1870, the deficiency percentage of registration was surely not larger in the 39½ year period 1837–1876, than in the 30-year period 1841–1870.

We are far from suggesting that the test made by estimating the births with " the English Life Table from the number of children under ten years of age " is conclusive ; but this test, which indicated that the proportion of unregistered births was 3½ per cent., is certainly preferable to an estimate of 5 per cent., based on the mere guess that the actual birth rate for the 39½ years will have been 36 per 1,000. It may seem futile to worry about such an apparently negligible difference between two estimates. But we have deliberately chosen this example in order to demonstrate that far-reaching

[1] *Thirty-Fifth Annual Report* (1872), p. v.

[2] See *Census of England and Wales for the Year* 1871, vol. iv, *General Report*, pp. xxiv, 54–55.

consequences may result, even from what would seem a trifle. The birth rates computed from the registered births in 1841–1850, 1851–1860, 1861–1870, and 1871–1875 were 32·6; 34·1; 35·2; and 35·5. The birth rates computed from the "calculated" births (assuming that the unregistered births in 1871–1875 averaged 10,000) were 34·8; 35·2; 35·9; and 36·0. It is quite probable that the actual birth rate did not increase as much as the birth rate computed from the registered births indicates, since registration in course of time became less deficient. But there is no basis for the opinion expressed first by Farr, and generally accepted since,[1] that the birth rate in England did not increase at all between 1841 and 1875. No one can tell whether registration in that period was deficient by 3·5 or by 5 per cent. In the third quarter of the century the deficiencies were so small that no numerical test could possibly prove them conclusively, since even the best test involves a considerable margin of error. In a case like this the student has only two alternatives: he may accept the birth rates computed from the "calculated" births, and conclude that the actual birth rate increased slightly; or he may say (and this seems the preferable course): *non liquet*. But he should under no circumstances accept an estimate of the deficiency of birth registration computed on the assumption that such and such average birth rate prevailed.

In former times registration referred to baptisms rather than to births. In many cases the number of baptisms will approach quite closely the number of births. But the student, before using figures for baptisms instead of figures for births, should always make sure of two things: (1) that the religious minorities who do not have their children baptized are negligible; (2) that the registers include the baptisms of young children only.

The first fact was already realized by John Graunt (1662), who tested the number of baptisms by relating it to the number of burials, of miscarriages, and of women dying in

[1] See, for instance, Newsholme, Sir Arthur, *The Elements of Vital Statistics*, new ed., pp. 92–93, London, 1923.

child-bed.[1] One century later (1759), the editor of *A Collection of the Yearly Bills of Mortality*, in discussing the London registers, clearly showed the gaps caused by omissions of births in records of baptisms : [2]

> Our bills must plainly be a very defective register of births, as
> 1. They extend only to baptisms, which are administered according to the rites and usage of the church of England. Very few of the numerous body of dissenters, and none of the Roman-catholicks, are included in this number.
> 2. They take no notice of those, who die unbaptized ; or of those, perhaps no inconsiderable number among the lowest class of the people, who never are brought to be baptized at all.

As an illustration of the errors which may emanate from an identification of baptisms and births in case many adults are baptized, it may be mentioned that the registers of baptisms in the city of Buenos Aires in the years 1601–1610 run as follows : 35, 74, 27, 533, 24, 43, 353, 47, 109, and 101, while the population for 1602 has been estimated at 500.[3] The enormous numbers of baptisms were due to the fact that many negro slaves were brought into the city for the purpose of baptism.

Attention should finally be called to the fact that the ambiguity of the term " birth " sometimes creates confusion. Birth means both the act of bringing forth a child or more (in case of twins, etc.), and the fact of a child being born. The student should therefore always make sure whether the birth figures refer to the number of confinements, or to the number of children born. In this book we understand by number of births the number of live-born.

2. Live-born and Still-born

Birth figures sometimes include still-born, and sometimes comprise live-born only. Before making comparisons, the student should always ascertain the scope of the figures. Whenever vital statistics give live-born and still-born

[1] See Graunt, *Natural and Political Observations upon the Bills of Mortality*, 1st ed., p. 30, London, 1662.

[2] *A Collection of the Yearly Bills of Mortality from* 1657 *to* 1758 *inclusive*, etc., p. 4, London, 1759.

[3] See *Censo General de Población, Edificación, Comercio é Industrias de la Ciudad de Buenos Aires*, 1887, vol. i, pp. 474–475.

separately, the problem arises whether live-born only or all births should be considered. Since the statistical definitions of live-born and still-born have changed in the course of time, and also vary between different countries, it would seem preferable to neglect any distinction and to consider only total births. But since Great Britain, prior to 1 July, 1927, did not register still-births at all, and since there are still some countries which do not register them, while on the other hand the exclusive publication of figures for total births has vanished, it seems advisable to confine international studies to the live-born. The student should, however, keep in mind that the numbers of live-born are slightly affected by the definition of live-born in use at the different periods and in the various countries. The statistics of live-born in England and Denmark thus include all children who have shown any sign of life after birth, while in France and Belgium they exclude children who were born alive, but died within three days after birth without birth registration. The proportion of such children amounts in both countries to about 0·7 per cent of the live-born and to 15 or 16 per cent of the still-born.[1]

3. Legitimate and Illegitimate Births

The newly-born in vital statistics are usually subdivided into legitimate and illegitimate. In itself, of course, this distinction does not cause such difficulties as the distinction between live-born and still-born ; but it raises very intricate and practically insoluble problems in connection with the measurement of fertility.

Legitimate children may be born to married, widowed, and divorced women ; illegitimate children may be born to single, married, widowed, and divorced women. The usual method of relating the legitimate births to the married women and the illegitimate births to the sum of the single, widowed, and divorced women, therefore, is not absolutely correct. But it is difficult to appraise the exact purport of the error, since there are very few countries which publish the number of births

[1] See Kuczynski, *The Balance of Births and Deaths*, vol. i, pp. 63–66, New York, 1928.

according to the civil status of the mother. Sweden and Prussia have done so for many years ; [1] Hungary for one year (1897) classified the illegitimate births according to the marital condition of the mothers.

TABLE 1.—LEGITIMATE AND ILLEGITIMATE BIRTHS ACCORDING TO CIVIL STATUS OF MOTHERS : SWEDEN, 1881–1930 ; PRUSSIA, 1922–1932 ; HUNGARY, 1897.[2]

Civil Status of Mother	Sweden		Prussia		Hungary proper Illeg.[3]	Croatia-Slavonia Illeg.[3]
	Leg.	Illeg.	Leg.	Illeg.		
Single . .	—	791,728	—	769,458	55,189	5,591
Married . .	5,622,028	8,652	7,240,584	645	282	282
Widowed .	8,240	26,565	8,758	26,479	5,142	768
Divorced .			2,095	12,884	369	33
Unknown .	—	—	—	465	1,661	134
Total . .	5,630,268	826,945	7,251,437	809,931	62,643	6,808

TABLE 2.—LEGITIMATE AND ILLEGITIMATE BIRTHS ACCORDING TO CIVIL STATUS OF MOTHERS : SWEDEN, 1871–1930 ; AND PRUSSIA, 1922–1932. (Per cent.) [4]

Period	Legitimate Births		Illegitimate Births			
	Married Women	Widows and Divorced	Married Women	Widows and Divorced	Engaged	Others
			Sweden			
1871–1880 . .	99·80	0·20	0·90	3·70	9·24	86·16
1881–1890 . .	99·84	0·16	1·09	3·12	8·65	87·14
1891–1900 . .	99·84	0·16	1·41	3·64	8·87	86·08
1901–1910 . .	99·85	0·15	1·26	3·40	9·53	85·81
1911–1920 . .	99·84	0·16	1·08	3·02	13·87	82·03
1921–1930 . .	99·90	0·10	0·41	2·93	24·90	71·76
			Prussia			
1922–1932 . .	99·85	0·15	0·08	4·86	95·06	

[1] The figures for Prussia, prior to 1922, however, were all wrong.

[2] See Sveriges Officiella Statistik, " Sammandrag, 1913," *Statistisk Tidskrift*, 1913, p. 16 ; *Befolkningsrörelsen Översikt för Åren* 1911–1920, p. 182 ; *ibid.*, 1924–1925, p. 4 ; *ibid.*, 1930, p. 4 ; *Preussische Statistik*, Heft 274, p. 5*, 276, p. 7*, 282, p. 7*, 287, p. 7*, 289, p. 7*, 294, p. 7*, 298, p. 8*, 301, p. 8* ; *Zeitschrift des Preussischen Statistischen Landesamts*, vol. 71, pp. 44, 382, vol. 72, p. 96 ; *Ungarische Statistische Mittheilungen*, New Series, vol. xxii, p. 99*.

[3] Live- and still-born.

[4] For Sweden, see Sveriges Officiella Statistik, *Befolkningsrörelsen År* 1930, p. 13*, for Prussia computed from Table 1.

In Sweden and in Prussia the numbers of legitimate births to widows and divorced, and of illegitimate births to married women are both very small. In Croatia-Slavonia the births of illegitimate children to married women constituted not less than 4·2 per cent of all illegitimate births, as against 1·0 per cent in Sweden, 0·5 per cent in Hungary proper, and 0·08 per cent in Prussia; but even here they constituted only 0·3 per cent of all births to married women. It may, therefore, be taken for granted that for most countries the error emanating from the assumption that all legitimate and only legitimate children are born to married women, and that all illegitimate and only illegitimate children are born to single, widowed, and divorced women is not serious. It would, however, be a big mistake to conclude therefrom that the number of legitimate births, on the one hand, and of illegitimate births, on the other, should indicate to what extent the sexual intercourse of married and of unmarried women leads to births. We can perhaps best demonstrate the fallacy of such a conclusion by showing the most important types of legitimate and illegitimate children which play a part in the measurement of fertility. We shall choose as an example a woman who cohabited with A in 1917, with B from 1918 to 1922, with C in 1924, with D from 1925 to 1927, and with E from 1929 on. She married B in 1919, became a widow in 1922, and in 1925 married D, who got a divorce in 1930.

Order of Birth	Year of Conception	Civil Status of Woman		Father	Conception	Birth
		at Time of Conception	at Time of Birth			
1	1917	Single	Single	A	Illeg.	Illeg.
2	1918	Single	Single	B	Illeg.	Illeg.[1]
3	1919	Single	Wife	B	Illeg.	Leg.
4	1921	Wife	Wife	B	Leg.	Leg.
5	1922	Wife	Widow	B	Leg.	Leg.
6	1924	Widow	Widow	C	Illeg.	Illeg.
7	1925	Widow	Wife	D	Illeg.	Leg.
8	1927	Wife	Wife	D	Leg.	Leg.
9	1929	Wife	Wife	E	Illeg.	Illeg.[2]
10	1931	Divorced	Divorced	E	Illeg.	Illeg.

[1] Legitimised by subsequent marriage.

[2] Not recognized by D.

The children illegitimately conceived and illegitimately born to unmarried women—they are represented in the preceding table by (1), (2), (6), and (10)—comprise a great variety of cases ranging from the unwanted child of a prostitute who does not know its father, to the child whose father died the day before marriage was to take place. The statistics of some countries provide an insight into the numerical importance of certain groups of parents of illegitimate children. The statistics for Hungary proper, 1897, thus gave the number of the illegitimate children acknowledged by their fathers; these were mostly the children of parents who lived together, and who for one reason or another had not yet married, but may have married later. The Swedish statistics for many years have shown the number of illegitimate births to females engaged to be married. Many statistics, moreover, show the number of illegitimate children legitimised by subsequent marriage.[1]

The children illegitimately conceived but legitimately born, represented in the preceding table by (3) and (7), likewise comprise a great variety of cases, ranging from the child whose conception caused its parents to marry to the child conceived the day before marriage. The number of these antenuptial conceptions followed by births can be derived approximately from all statistics which classify the births according to the duration of marriage. A plausible method of ascertaining the minimum number consists in adding to the children born in the first seven months of marriage two-thirds of those born in the eighth month and one-third of those born in the ninth month.

The usual method of measuring fertility of married and of unmarried women consists in relating the legitimate children, represented in the preceding table by (3), (4), (5), (7), and (8), to the married women, and the illegitimate children, represented by (1), (2), (6), (9), and (10), to the unmarried women. The error emanating from relating the legitimate children of widows (5) to married women and the illegitimate children

[1] According to the statistics for Saxony 35 per cent of the illegitimate children born in 1925 had been legitimised before 1930, while 15 per cent had died (see *Statistisches Jahrbuch für den Freistaat Sachsen*, 1930, p. 32).

of married women (9) to unmarried women has already been disposed of as not serious. The children illegitimately conceived and illegitimately born—(1), (2), (6), (9), and (10)—should in any case be related to the unmarried women, no matter whether their fertility is to be measured according to their civil status at the time of birth or at the time of conception. In a similar manner, children legitimately conceived and legitimately born—(4), (5), and (8)—should in any case be related to the married women, no matter whether their fertility is to be measured according to their civil status at the time of birth or at the time of conception. But the children illegitimately conceived and legitimately born—(3) and (7)—need a distinctive treatment according to the object of the study. If this object is to measure fertility according to the civil status at the time of birth they should be combined with all other legitimate children—(4), (5), and (8)—and should be related to the married women. If the object is to measure fertility according to the civil status at the time of conception, they should be segregated from the other legitimate children and should be combined with all other illegitimate children—(1), (2), (6), (9), and (10). The number of children illegitimately conceived but legitimately born, as a rule, is very considerable. According to a study made in 1907, they constituted in various countries and cities between 5 and 13 per cent of all legitimate children, and between 20 and 44 per cent of all first-born legitimate children; the number of children illegitimately conceived was by 30 to 130 per cent higher than the number of children illegitimately born.[1]

The number of legitimate children conceived before marriage is not only important in connection with the measurement of fertility due to the sexual intercourse in or out of wedlock; it serves also as a gauge for measuring the proportion of marriages, the fertility of which is already assured at the time of marriage. The percentage of such marriages in various countries and cities lay between 18 and 37.

In order to cover the children conceived before marriage

[1] See Kuczynski, "Zur Statistik der Fruchtbarkeit," *Bericht über den XIV. Internationalen Kongress für Hygiene und Demographie*, Berlin, 23–29 September, 1907, vol. iii, pp. 1479–1480.

and taken over into matrimony fully, it is also necessary to take account of the children legitimised through marriage. The number of such children in the various countries and cities lay between 9 and 16 per 100 marriages. Attention, however, should be paid to the fact that in the case of some marriages more than one child is legitimised, and that the marriages of pregnant brides comprise marriages through which children born at an earlier period are legitimised. In order to ascertain the proportion of marriages through which illegitimately conceived children are taken over into matrimony, account should only be taken: (1) of the number of marriages through which children are legitimised (not of the total number of legitimised children); and (2) only of those marriages in which the child illegitimately conceived but legitimately born is the first child of such marriage. The percentage of marriages in which an illegitimately conceived child was living at the time of marriage, or was born after marriage, varied in a number of countries and cities between 30 and 46. But the percentage of marriages in which the bride had borne or conceived a child before marriage is actually, of course, still larger because no account has been taken so far of cases where children born to the bride before marriage were not legitimised because those children had died or because the bridegroom was not their father. It is possible to include also those children for a number of rural districts in Denmark where in 45 per cent of all marriages illegitimately conceived children were taken over into matrimony in 1878–1882. Nine per cent of the brides had had children with their bridegrooms, 1 per cent with their bridegrooms and other men, 7 per cent with other men. One-half of the brides had conceived children before marriage, while one-half had not conceived a child because they had either not had any sexual intercourse or intercourse without ensuing conception. On the other hand, 15 per cent of all brides remained childless after marriage. But in appraising this percentage, account should be taken of the fact that some women did not remain childless probably only because they had already conceived a child before marriage.

Antenuptial conceptions thus play a large part in determining the number of childless marriages, and in particular the legitimisation of children causes a great deal of trouble in connection with the computation of the percentage of sterile marriages. The legitimised children do not appear, it is true, among the legitimate births, but they play a part in determining the order of the legitimate births after marriage. In marriages through which two children, for instance, are legitimised, the first child born after marriage is not recorded as first child but as third child of the marriage. When it was found that in Berlin 730 first children had been borne by each 1,000 married women in 1886–1900, the distinguished director of the Statistical Office of Berlin, Hirschberg, concluded that 27 per cent of all Berlin marriages were sterile, and the eminent Norwegian statistician, Kiaer, in a special supplement to his well-known study on matrimonial fertility, gave an explanation of this extraordinary barrenness of the Berlin women. As a matter of fact, the total number of first children born to each 1,000 married women—including first children legitimised after marriage—was not 730 but 822, and the percentage of sterile married women was not 27, but 17·8.

The student who realizes the intricacy of the problems connected with the computation of fertility of married and of unmarried women will possibly be inclined to forego such computations altogether. We dare not dissuade him from yielding to this inclination. Fertility of married women is doubtless a most interesting matter. But the usual method which measures fertility of married women by the number of legitimately born children is quite misleading. On the one hand it includes indiscriminately the children conceived before, but born after marriage. On the other hand it takes no account of the legitimised children. The refined method suggested on the preceding pages is, however, hard to apply, since the cases are very rare where all the necessary data are available.

4. Tests of Accuracy

We have submitted in the first section of this chapter some methods of testing the completeness of birth figures. A task of not minor importance is the examination of the accuracy of the specific data from which the student of population wants to draw conclusions. In some cases such an examination is an easy matter. It is, for instance, a well-known fact that there is a marked tendency, especially among illiterate people, to report age in round numbers, that is, in numbers ending with 0 or 5, or in even rather than odd numbers. Thus the birth statistics of the Ukraine for 1926 reported 80,902 mothers at 28 years ; 45,555 at 29 ; 73,117 at 30 ; 27,381 at 31; and 44,583 at 32.[1] A scrutiny of such or similar figures should make us distrust the accuracy of the data referring to individual years of age.

We should also distrust the accuracy of figures showing a particularly large number of confinements at extreme ages. If one finds, for instance, that the reported number of live- and still-born to mothers under 15 years in France in 1901–1905 was as high as 2,189, one might be suspicious and should try to ascertain further details about such births and about their numbers in preceding and subsequent periods. If one then found that practically all such births in 1901–1905 were illegitimate births, and that the numbers were not much smaller before 1901 nor after 1905, it would furnish no proof of the inaccuracy of the figures for 1901–1905, but an analysis of the relevant statistics would actually yield the results shown in Table 3, p. 24.

It appears : (1) that in 1892, the first year in which the births were recorded according to the age of the mother, the births to mothers under 15 numbered not less than 2,432, that is in one year even more than in the five years 1901–1905, and that the yearly number of such births decreased to 310 in 1906 and then dropped to 119 in 1907 ;

(2) that the reported number of legitimate births to mothers under 15 years decreased from 1,553 in 1892 to 135 in 1906,

[1] See Statistika Ukraïni (Series I), No. 154, p. 49.

TABLE 3.—BIRTHS TO MOTHERS UNDER 15 YEARS IN FRANCE, 1892–1913.[1]

Years	Live-born			Still-born			Total Births		
	Leg.	Illeg.	Total	Leg.	Illeg.	Total	Leg.	Illeg.	Total
1892	641	701	1,342	912	178	1,090	1,553	879	2,432
1893	294	302	596	585	61	646	879	363	1,242
1894	271	276	547	569	92	661	840	368	1,208
1895	249	220	469	571	106	677	820	326	1,146
1896	270	244	514	342	86	428	612	330	942
1897	67	178	245	127	88	215	194	266	460
1898	142	121	263	109	99	208	251	220	471
1899	101	199	300	164	60	224	265	259	524
1900	131	206	337	273	100	373	404	306	710
1901	74	183	257	181	33	214	255	216	471
1902	142	169	311	183	26	209	325	195	520
1903	64	177	241	222	46	268	286	223	509
1904	46	160	206	88	28	116	134	188	322
1905	66	183	249	85	33	118	151	216	367
1906	131	172	303	4	3	7	135	175	310
1907	—	109	109	—	10	10	—	119	119
1908	1	113	114	—	11	11	1	124	125
1909	2	125	127	—	4	4	2	129	131
1910	2	98	100	—	7	7	2	105	107
1911	5	123	128	—	11	11	5	134	139
1912	4	127	131	—	10	10	4	137	141
1913	—	129	129	—	8	8	—	137	137

and then dropped to 0 in 1907, while the number of illegitimate births to mothers of that age group decreased from 879 in 1892 to 175 in 1906 and dropped to 119 in 1907;

(3) that of the 6,969 legitimate births to mothers under 15 years reported in 1892–1905 not less than 4,411, or 63 per cent, were still-births, while of the 4,355 illegitimate children born to such mothers not more than 1,036, or 24 per cent, were still-born.

In this case, there would be no further need to examine the figures. There would, in particular, be no need to ascertain that the large number of legitimate births prior to 1907 cannot be reconciled with the negligibly small number of married

[1] See Statistique Générale de la France: *Statistique du mouvement de la population*, 1911–1913, pp. 36–37; *Statistique internationale du mouvement de la population*, vol. i, p. 365; vol. ii, p. 112.

women under 15 years.[1] The results pointed out suffice to indicate that none of the data before 1907 can be accepted as trustworthy.

As a rule, the task of the student becomes more difficult when he has to appraise the accuracy of data relating to births to mothers over 50 years. If the number of such births appears very large, he should first find out the corresponding numbers for subsequent periods. In the case of France it would appear, for instance, that the number of such births was extraordinarily large prior to 1907, that it dropped from 1,027 in 1906 to 64 in 1907, and that it stayed on the lower level to the present time. No further proof of the inaccuracy of the data prior to 1907 would be needed in that case.[2] The situation is not so clear in the case of Bulgaria, where the reported yearly number of live-born to mothers over 50 years oscillated from 1901 to 1907 between 897 and 1,185, averaging 1,038.[3] No data are available for any subsequent period, and the ratio of legitimate births to married women, of course, offers no clue since the number of married women at that age is very large. If suspicious of the extraordinarily high figures we may be tempted to test their accuracy by consulting the statistics of neighbouring countries and, turning to Serbia, we find, indeed, that the reported number of births to mothers

[1] Only nine married women born after 1885 were reported at the census of 24 March, 1901 (see *Annuaire Statistique de la France*, 1906, p. 7).

[2] Until 1907 the tables of vital statistics were prepared by the mayors for their districts, while from 1907 on individual forms for each birth, etc., were filled in by the registrars and sent to the central statistical office, which on the basis of those forms prepared the tables. The central office was aware in a general way that the new method yielded more satisfactory results (see *Statistique du mouvement de la population*, 1907–1910, pp. v–vi), but it did not realize, for instance, that with the old method far too many births to very young and to very old mothers had been reported. It computed the fertility rates of married women in the various age groups for 1892–1895 and 1906–1910 and came to the conclusion : " It is then at the extreme ages that fertility has decreased most, due to the voluntary limitation of the family to a small number of children " (*ibid.*, p. viii). If the office had tested the accuracy of the basic data by preparing a table like the one given above it would have recognized at once that the data for 1892–1895 were erroneous and never would have drawn far-reaching conclusions from a comparison of the figures for the two periods.

[3] See *Mouvement de la population pendant l'année* 1901, *Résultats en général pour la Bulgarie entière*, p. 17 ; 1902, p. 15 ; 1903, p. 15 ; 1904, p. 15 ; 1905, p. 15 ; 1906, p. 17 ; 1907, p. 22.

over 50 in 1901–1907 averaged 29 only.[1] We might, therefore, rightly argue that the difference between the figures for Bulgaria and for Serbia is so enormous that it can be explained only to a small part by the two facts that the women were somewhat more numerous in Bulgaria than in Serbia, and that the proportion of Mahometan women over 50, who according to the Bulgarian statistics were still much more fertile than the average Bulgarian woman over 50, was considerably larger in Bulgaria than in Serbia. But we would be wrong in drawing therefrom any final conclusion. If we push the investigation a little further by examining the age data revealed at the censuses of 1900 in Bulgaria and in Serbia, we find the following perplexing situation :

Years of age	Women	
	Bulgaria [2]	Serbia [3]
44–45	4,523	23,241
45–46	42,333	6,119
46–47	7,237	3,126
47–48	3,950	8,694
48–49	14,625	2,327
49–50	3,186	39,706
50–51	55,115	1,969
51–52	2,259	4,107
52–53	6,527	2,406

While in Bulgaria the women of 50 appear to be 17 times as numerous as the women of 49, in Serbia the women of 49 appear to be 20 times as numerous as the women of 50. The explanation for the divergence is probably that in both countries an unduly large number of women gave 50 years as their age, but that in Serbia the women were supposed to give the age at their next birthday, and that the central statistical office entered as 49 years old those women who had given their age as 50.

[1] See *Mouvement de la population dans le Royaume de Serbie pour la période de* 1900 *à* 1905, pp. 186, 324, 462, 604, 746 ; *Annuaire Statistique du Royaume de Serbie*, 1906, p. 155 ; 1907, p. 102.

[2] See *Résultats généraux du recensement de la population dans la principauté de Bulgarie au* 31 *décembre* 1900, Ière Livraison, p. 136.

[3] See *Dénombrement de la population dans le Royaume de Serbie le* 31 *décembre* 1900, Deuxième Partie, pp. 81–83.

Since the age of mothers in Serbia has not been published by years of age (but only by quinquennial age groups), we have no direct proof that the number of mothers recorded as 50 years was unduly low, but the age of the deceased females is given by years of age, and a study of the figures shows that in 1901, for instance, the number of women reported as having died at 47, 48, 49, 50, 51, and 52 years was 127, 41, 600, 37, 97, and 65 respectively.[1] Here, again, the number of women reported as 50 years old was unduly low. It seems safe to conclude that the number of mothers who in Serbia had given 50 years as their age was likewise unduly low, and that, therefore, the reported number of mothers of 50 years or more (average for 1901–1907 : 29) considerably lagged behind the truth.

As for Bulgaria, the age of mothers has not been published by years of age since 1900, but it was published for 1898–1900 for each year, including 50 years, and it appears that in 1900, for instance, the reported number of births (including still-births) to mothers of 47, 48, 49, and 50 years was 196, 467, 129, and 693.[2] The number of mothers reported as 50 years old, therefore, was unduly large. The reported number of mothers of 50 years or more (average for 1901–1907 : 1,038) in Bulgaria, then, considerably exceeded the actual number.

The foregoing discussion indicates that while the right appraisal of the statistical material is sometimes very easy, it is sometimes rather difficult, and the student frequently will have to work out his own methods for testing its accuracy. We shall here confine ourselves to giving one more example in order to indicate what procedure he might follow.

The Hungarian Statistical Office has published for 1903–1925 detailed tables of the number of children born to married women during their last marriage, as ascertained at the death of those women.[3] The data cover for 1903–1915 the entire

[1] See *Mouvement de la population dans le Royaume de Serbie*, 1900–1905, pp. 260–261.

[2] See *Mouvement de la population pendant l'année* 1900, *Bulgarie entière*, p. 101.

[3] See *Publications statistiques Hongroises*, New Series, vol. 22, pp. 27*–37*, 82*–85*, 700–748; *ibid.*, vol. 32, pp. 63*–69*, 700–758; vol. 50, pp. 63*–71*, 822–880; vol. 70, pp. 32*–39*, 122–136; vol. 74, pp. 73*–83*, 192–201.

kingdom, comprising Hungary proper and Croatia-Slavonia; for 1916–1918 Hungary proper only, and for 1919–1925 the present territory of Hungary.

First of all, we must find out whether these statistics are all-inclusive. Since the Hungarian Office does not discuss this point in its otherwise quite comprehensive analysis of the figures, we should ascertain the number of deceased married women from the general mortality statistics. We then obtain the following results:

TABLE 4.—NUMBER OF DECEASED MARRIED WOMEN, HUNGARY, 1903–1925.[1]

Year	Deceased Married Women according to Mortality Statistics		Deceased Married Women according to Fertility Statistics	
	Hungary proper	Croatia-Slavonia	Hungary proper	Croatia-Slavonia
1903	47,819	7,583	43,773	6,840
1904	49,057	7,617	46,734	6,994
1905	54,081	8,506	51,642	8,000
1906	48,702	7,369	45,955	6,903
1907	50,623	7,699	47,619	7,254
1908	49,933	8,372	47,518	7,779
1909	49,187	7,881	47,379	7,375
1910	47,092	7,722	45,101	7,210
1911	49,604	8,130	47,453	7,583
1912	48,386	7,709	45,558	7,125
1913	47,660	7,801	44,949	7,225
1914	49,319	7,817	45,684	7,103
1915	53,201	9,070	49,824	8,404
1916	50,259	—	46,783	—
1917	51,582	—	47,919	—
1918	72,510	—	67,033	—
1919	20,947	—	17,945	—
1920	21,454	—	18,386	—
1921	18,870	—	16,700	—
1922	20,569	—	16,680	—
1923	19,685	—	17,343	—
1924	21,059	—	18,310	—
1925	18,361	—	16,578	—

[1] See *ibid.*, vol. 22, pp. 327, 329, 331, 702, 706, 710; vol. 32, pp. 638–639, 702, 706, 710; vol. 50, pp. 738–741, 824, 828, 832, 836; vol. 70, pp. 102–105, 122; vol. 74, pp. 138–139, 192–196. From 1919 on, the data refer to the present territory of Hungary.

The number of deceased married women, as shown in the mortality statistics, is nearly complete, since the marital condition was known for almost all the deceased. But the number of cases which—evidently on account of lack of information on the number of children—were omitted from the fertility statistics, was by no means negligible. It amounted for Hungary proper (1903–1918) to 4 or 8 per cent, for Croatia-Slavonia (1903–1915) to 6 or 10 per cent, and for post-war Hungary (1919–1925) to 10 or 19 per cent. It is thus necessary to watch whether the gaps were particularly large in specific groups.

We shall now show the final results of this investigation for 1903–1915 :

TABLE 5.—AVERAGE NUMBER OF CHILDREN BORN PER MARRIAGE DISSOLVED BY DEATH OF WIFE, HUNGARY, 1903–1915.[1]

Year	Hungary proper	Croatia-Slavonia	Kingdom
1903	4·22	3·67	4·14
1904	4·16	3·60	4·09
1905	4·10	3·73	4·05
1906	4·06	3·86	4·04
1907	4·06	3·86	4·04
1908	4·07	3·91	4·04
1909	4·04	3·87	4·01
1910	4·06	4·00	4·05
1911	4·13	4·06	4·12
1912	4·09	4·04	4·08
1913	4·10	4·07	4·09
1914	4·05	4·06	4·05
1915	4·07	4·07	4·07

An examination of the last column, referring to the entire kingdom, would not arouse any suspicion about the accuracy of the underlying data, and the same is true of the first column, referring to Hungary proper. But the figures for Croatia-Slavonia show for 1905–1911 an upward trend which does not seem altogether plausible. What other data can be consulted in order to test the accuracy of those figures ? The Hungarian Office has grouped the dissolved marriages according to the

[1] See *ibid.*, vol. 22, p. 29* ; vol. 32, p. 713 ; vol. 50, p. 839 ; vol. 70, p. 125.

number of children. Let us examine the results for Croatia-Slavonia :

TABLE 6.—MARRIAGES DISSOLVED BY DEATH OF WIFE ACCORDING TO NUMBER OF CHILDREN, CROATIA-SLAVONIA, 1903–1915.[1]

Year	Number of Children			Total
	0–5	6–10	11 and more	
1903	5,107	1,571	162	6,840
1904	5,260	1,584	150	6,994
1905	5,865	1,918	217	8,000
1906	5,007	1,693	203	6,903
1907	5,234	1,788	232	7,254
1908	5,538	1,970	271	7,779
1909	5,319	1,801	255	7,375
1910	5,042	1,861	307	7,210
1911	5,272	2,006	305	7,583
1912	4,995	1,834	296	7,125
1913	5,021	1,916	288	7,225
1914	4,924	1,902	277	7,103
1915	5,847	2,195	362	8,404

There was, then, a marked increase in the number of marriages reported to have had more than five children, and especially more than ten children. A similar examination of the figures for Hungary proper does not reveal such a trend. The number of dissolved marriages with less than six children was here in 1903 and 1914 respectively : 29,367 and 31,764 (1915 : 34,734) ; the number with from six to ten children : 12,104 and 11,653 (12,630) ; the number with more than ten children : 2,302 and 2,267 (2,460).

The Hungarian Office has grouped the marriages also according to their duration. Let us compare the results for Hungary proper and Croatia-Slavonia (see Table 7, p. 31).

While in Hungary proper the average number of children decreased in each group, Croatia-Slavonia showed an increase which was particularly marked for the marriages dissolved after 20 or more years of duration.

The Hungarian Office finally, since 1905, has grouped the marriages according to the ages of the deceased. We shall

[1] See *ibid.*, vol. 22, pp. 703, 707, 711 ; vol. 32, pp. 703, 707, 711 ; vol. 50, pp. 825, 829, 833, 837 ; vol. 70, p. 123.

TABLE 7.—AVERAGE NUMBER OF CHILDREN BORN PER MARRIAGE DISSOLVED BY DEATH OF WIFE ACCORDING TO DURATION OF MARRIAGE, HUNGARY, 1903–1915.[1]

Years	Duration of Marriages in Years				Total Marriages
	Less than 5	5–9	10–19	20 and more	
Hungary proper					
1903-1905	1·10	2·53	4·08	5·32	4·16
1906–1908	1·04	2·42	3·96	5·32	4·06
1909–1912	1·04	2·38	3·83	5·21	4·08
1913–1915	1·04	2·36	3·78	5·14	4·07
Croatia-Slavonia					
1903–1905	1·04	2·34	3·83	4·62	3·67
1906–1908	1·16	2·60	4·07	4·93	3·88
1909–1912	1·08	2·43	3·96	5·05	3·99
1913–1915	1·10	2·40	3·95	5·08	4·07

again reproduce the results for Hungary proper and for Croatia-Slavonia, adding this time also the results for the periods 1916–1918 and 1919–1925 :

TABLE 8.—AVERAGE NUMBER OF CHILDREN BORN PER MARRIAGE DISSOLVED BY DEATH OF WIFE ACCORDING TO AGE OF DECEASED, HUNGARY, 1903–1925.[2]

Years of age	Hungary proper				Hungary		Croatia-Slavonia		
	1906–1908	1909–1912	1913–1915	1916–1918	1919–1922	1923–1925	1906–1908	1909–1912	1913–1915
14–19	0·56	0·60	0·62	0·55	0·49	0·63	0·66	0·62	0·56
20–24	1·31	1·31	1·32	1·22	0·93	1·15	1·22	1·32	1·28
25–29	2·48	2·41	2·42	2·18	1·87	1·79	2·41	2·37	2·41
30–34	3·71	3·60	3·47	3·19	2·97	2·76	3·64	3·65	3·60
35–39	4·85	4·65	4·54	4·14	3·94	3·77	4·68	4·78	4·73
40–44	5·20	5·11	4·98	4·81	4·60	4·15	5·31	5·36	5·27
45–49	5·01	5·01	4·94	4·89	4·55	4·41	4·99	5·09	4·89
50–59	4·88	4·95	4·89	4·87	4·76	4·70	4·65	4·73	4·81
60–69	4·50	4·63	4·71	4·77	4·79	4·90	4·16	4·43	4·58
70 and more	4·12	4·15	4·14	4·27	4·33	4·55	3·80	3·85	3·99

For Croatia-Slavonia, the largest average number of children in each period was reported for the women deceased at the

[1] See *ibid.*, vol. 22, pp. 29*– 30* ; vol. 50, p. 64* ; vol. 70, p. 125.

[2] See *ibid.*, vol. 32, p. 750 ; vol. 50, p. 879 ; vol. 70, p. 133 ; vol. 74, p. 126*.

age of 40 to 44 years. With increasing age the average number of children decreased, and this decrease was strongest in the first period and weakest in the last period. In combining the results of the three tests, it is safe to conclude that in the earlier years the number of children born to the dissolved marriages was frequently understated for the older women who had been married for a long time and who had had many children.

The tests based on the number of children for all marriages dissolved by the death of the wife, and on the average number of children according to the duration of marriages, failed to prove an inadequacy of the data for Hungary proper. But the third test, based on the age of the deceased wives, shatters our faith in the accuracy of the data, at least, so far as the earlier periods are concerned. Here, again, we find for 1906–1915 the largest average number of children for the women deceased at the age of 40 to 44 years. Here, again, the average number of children decreased with increasing age, and this decrease was strongest in 1906–1908 and weakest in 1913–1915. It is true that the decrease was much less marked than in Croatia-Slavonia, and that a slight decrease might be explained by the fact that among the marriages dissolved by the death of an older woman the cases are rather frequent where the wife married in the later stage of her child-bearing period, or even after its expiration. But for the post-war years the highest average number of children was actually reported for the wives deceased at the age of 60 to 69 years. It therefore seems that in pre-war times, even in Hungary proper, the number of children born to the dissolved marriages was pretty often understated in the case of older women.

CHAPTER II

MEASUREMENT OF FERTILITY BY EXCLUSIVE USE OF VITAL STATISTICS

1. Ratio of Births to Marriages

The oldest method of measuring fertility depends on relating the number of births occurring in a certain period to the number of marriages contracted in that period. The founder of vital statistics, John Graunt (1662), used this method, and from the fact that in " a certain Parish in Hampshire " 1,568 marriages had been concluded and 6,339 children christened between 1569 and 1658, derived the following conclusion : [1]

> That every Wedding one with another, produces four Children, and consequently, that that is the proportion of Children, which any Marriagable man, or woman may be presumed shall have. For, though a man may be Married more than once, yet, being once Married, he may die without any Issue at all.

This method has been used frequently till to-day. Its limitations have been very well summarized by Malthus (1826) : [2]

> If we suppose a country where the population is stationary, where there are no emigrations, immigrations, or illegitimate children, and where the registers of births deaths and marriages are accurate, and continue always in the same proportion to the population, then the proportion of the annual births to the annual marriages will express the number of children born to each marriage, including second and third marriages . . .

The principal defects of Graunt's method then are :

(1) The number of births per marriage does not show the

[1] Graunt, *Natural and Political Observations*, 1st ed., p. 64, London, 1662.

[2] Malthus, T. R., *An Essay on the Principle of Population*, 6th ed., vol. i, p. 472, London, 1826.

total fertility of married *persons*, since the same man or woman may appear twice or more among the marrying couples. The more this occurs the smaller the ratio of births to marriages is likely to be.

(2) Many illegitimate births have no relation whatsoever to the number of marriages.

(3) Births are not the outcome of contemporaneous marriages but of marriages which precede such births by a more or less long period. Present marriages may be more numerous or less numerous than the marriages which cause present births, either (*a*) because the persons of marriageable age have increased or decreased, or (*b*) because the inclination to marry has increased or decreased. Finally (*c*), the birth figures of a country include the births to parents who have immigrated after marriage; the marriage figures of a country include couples which emigrate after marriage.

Graunt (1662) himself had sensed the error arising from the indiscriminate inclusion of second and later marriages (1), but he did not realize its significance. The first to do so was Thomas Short (1750), who deserves credit also for having discovered the trouble caused by the inclusion of the illegitimate births (2), and by the emigration of married couples (3 *c*).

> For tho' the same Person's Marriages may be register'd several times, yet they are but once baptized or buried. For the same Reason, Bastards . . . should be substracted from the Number of Births allowed to each Wedding.[1]
>
> [In the] Prussian Dominions . . . the annual Births are not to the Weddings as 4 to 1. Because . . . where Subjects have no Property, there are great Crouds of Exports, as well married, as unmarried, and the Weddings of the former are registered there, but not the Births of their Children . . .[2]

But Short, like all his predecessors, John Graunt, William Petty, Gregory King, William Derham, was not aware that the births for other, more important, reasons cannot be safely related to the marriages of the same year. The first

[1] Short, Thomas, *New Observations, Natural, Moral, Civil, Political, and Medical, on City, Town, and Country Bills of Mortality*, pp. 34–35, London, 1750.

[2] *Ibid.*, pp. 243–244.

who had some misgivings in this direction was Süssmilch (1761), when he realized that the extraordinarily high ratio of births to marriages in Prussia in 1756 was caused by the sudden drop of marriages due to the outbreak of the war in that year.[1]

While Süssmilch noticed the effect of a sudden change in the number of marriages upon the ratio of births to contemporaneous marriages (3 *b*), he did not see that the population trend itself is a disturbing factor (3 *a*). This was first pointed out by Richard Price (1769): [2]

> The proportion of annual births to weddings has been considered as giving the true number of children derived from each marriage, taking all marriages one with another. But this is true only when, for many years, the births and burials have kept nearly equal. Where there is an excess of the births occasioning an increase, the proportion of annual births to weddings must be less than the proportion of children derived from each marriage; and the contrary must take place where there is a decrease.

We shall now take up each of those three defects and the remedies proposed:

(1) For the elimination of the disturbing influence of second and later marriages four methods have been suggested:

(*a*) to relate the legitimate births to the average number of marrying spinsters and bachelors;

(*b*) to relate the legitimate births to the number of marrying spinsters;

(*c*) to relate the legitimate births to the number of marrying bachelors;

(*d*) to relate the births from marriages between spinsters and bachelors to the marriages between such persons.

Short (1750) did not suggest any specific remedy. He merely said that allowance should be made for second and third marriages. Price, in 1769, recommended the first method.

[1] See Süssmilch, Johann Peter, *Die göttliche Ordnung in den Veränderungen des menschlichen Geschlechts*, 2nd ed., vol. 1, p. 176, Berlin, 1761.

[2] "Observations on the Expectations of Lives, the Increase of Mankind, the Influence of great Towns on Population, and particularly the State of London with respect to Healthfulness and Number of Inhabitants"; Letter from Richard Price to Benjamin Franklin, *Philosophical Transactions of the Royal Society of London*, vol. lix, 1769, p. 113.

He thought, however, that the deduction of marriages of widowers and widows " is not so considerable as to be of any particular consequence."

> Let 1 marriage in 10 be a 2d or 3d marriage on the side of either the man or the woman, and 10 marriages will imply 19 individuals who have grown up to maturity, and lived to marry once or oftener.[1]

But when, shortly thereafter, he became acquainted with actual data on the proportion of remarrying persons, he realized the importance of the deduction of marriages of widows and widowers : " Very wrong conclusions will be drawn if this allowance is not made."

> Let 1 marriage in 3 be a 2d or * 3d marriage on the side of either the man or the woman ; or, in other words, let one in six of all that marry be widows or widowers . . .[2]

He then concluded that one-sixth of the marrying persons should be deducted everywhere in order to allow for second and third marriages.[3]

Malthus (1807) applied the first method in his computations, and deducted fully one-sixth of the marriages.[4] But since he actually was more interested in " the prolifickness of married women " he denounced his own correction and recommended the second method : [5]

> . . . as it is found that the number of widowers who marry again, is greater than the number of widows, the whole of the correction [one-sixth] should not on this account be applied . . .

Sadler (1830) wrongly assumed that Malthus had considered the fourth method. By estimating the offspring

[1] " Observations on the Expectations of Lives," *Philosophical Transactions*, vol. lix, 1769, p. 111. See also Price, *Observations on Reversionary Payments*, etc., 1st ed., p. 193, London, 1771.

* This proportion is taken from fact.—In all Pomerania, during 9 years, from 1748 to 1756, the number of persons who married was 56,956 ; and of these, 10,586, were widows and widowers. Susmilch's Works, Vol. i, Tables, p. 98.

[2] *Observations on Reversionary Payments*, etc., 2nd ed., p. 193, London, 1772.

[3] See *ibid.*, p. 214.

[4] See Malthus, *An Essay on the Principle of Population*, 4th ed., vol. i, pp. 513, 519–525, and *passim*, London, 1807.

[5] *Ibid.*, p. 512.

from the various groups of marriages (spinsters and bachelors, spinsters and widowers, etc.) he found that the ratio of births from marriages between spinsters and bachelors to the marriages between such persons (4·26 : 1) was only by 6·5 per cent higher than the ratio of all legitimate births to all marriages (4 : 1), and this, he rather rashly concluded, " will suffice to shew how greatly Mr. Malthus has mistaken the influence of second and third marriages." [1]

The fourth method has never been applied in any official statistics; if for no other reason, because the antenuptial civil status of parents is hardly ever asked in connection with birth registration.[2] But the first, second, and third methods have been applied, for instance, in the English registration reports. William Farr at first used the second method: [3]

> In this investigation I only take the first marriages, because the first marriages represent the number of *persons* who marry annually; the rest of the total marriages, in a long interval of time, being repetitions of the act of marriage by the same individuals, many of whom in the ordinary marriage registers are counted twice.

Having shown that in 1839–41 there had been 4·7 (legitimate) births to each woman marrying for the first time and 4·3 to each marriage, he declares: [4]

> The latter is the usual, the former the best mode of stating this relation; for the object is to show the fecundity of women in different countries at different times; and the second marriages of women are, in this point of view, only a means of extending the period of childbearing to its natural term, and they cannot, on the average, be so fruitful as the first marriages, with which they are confounded.

Two years later Farr, without calling attention to this change, used the first method and found the number of births

[1] Sadler, Michael Thomas, *The Law of Population*, vol. ii, p. 156, London, 1830.

[2] The Czechoslovakian statistics convey some indirect information on this point by showing, for instance, that of 310,974 legitimate children born in 1925–1927 who were first-born to present marriages 274,269 were first children, while 36,705 were second, etc., children. See *Čechoslowakische Statistik*, vol. 77, pp. 206–209, Prague, 1932. See also the reference to some recent Italian statistics in Section 4 of this chapter.

[3] *Fourth Annual Report of the Registrar-General of Births, Deaths, and Marriages in England* (1840–41), p. 135.

[4] *Ibid.*, p. 137.

in 1842 to be " 4·26 to a marriage in England, and, if a correction be made for first marriages, 4·79 to every *two* persons married." [1] He used the first method again three years later.[2] But this was practically the last of it. In all further reports, with the exception of his report for the year 1867, in which he used the second and the third methods,[3] he applied the " usual," not " the best mode," [4] and we are not aware of any other attempt in England or any other country to exclude second and later marriages, although this procedure has been occasionally recommended in text-books,[5] and although there cannot be any doubt that it is the preferable procedure.

The indiscriminate inclusion of second and later marriages is particularly misleading when the results are used for a measurement of the reproduction of a population. This may be illustrated by an example taken from the recent book of Ernst Kahn. His argument runs as follows : If each newly-born child got married and had two children who would marry again and have each two children, the population would hold its own ; but since even in case of a low mortality one-third die unmarried three births per marriage are necessary to keep up the population. Hence, the population of the Ukraine, a country with a high mortality of children, and in 1929 only 3·1 births per marriage, would finally decrease if this ratio were to remain constant.[6] As a matter of fact, the ratio of births to all marriages is quite irrelevant ; the decisive ratio is that of births to first marriages. And since in the Ukraine 15 per cent of the marrying women (and 18 per cent of the marrying men) were widowed or divorced, the decisive ratio is not 3·1 : 1, but 3·1 : 0·85 = 3·6.

(2) In order to eliminate the disturbing influence of illegiti-

[1] *Sixth Report* (1842), p. xxx.
[2] See *Eighth Report* (1845), p. 3.
[3] See *Thirtieth Report* (1867), pp. 222–223, 226.
[4] See *Twenty-Seventh Report* (1864), p. xx ; *Twenty-Eighth Report* (1865), p. xi ; *Thirty-First Report* (1868), p. xxvii ; *Thirty-Seventh Report* (1874), p. xiv ; *Fortieth Report* (1877), p. xxxvii.
[5] See, for instance, Quetelet, A., *Sur l'homme et le développement de ses facultés, ou essai de physique sociale*, vol. i, pp. 80, 86–88, Paris, 1835 ; Wappaeus, J. E., *Allgemeine, Bevölkerungsstatistik*, vol. 2, p. 318, Leipzig, 1861 ; *Block, Traité théorique et pratique de statistique*, p. 421, Paris, 1878.
[6] See Kahn, *Der internationale Geburtenstreik*, p. 60, Frankfort, 1930.

mate births, Short (1750) recommended their exclusion. Subsequent authors followed the procedure suggested by Short and related legitimate births to marriages, but others, either unaware of the pitfall or quite aware of it, went on relating total births to marriages. Both methods involve errors. In his first discussion of the subject (1842) Farr, as has been shown, related the legitimate births to married women,[1] but added cautiously: "The actual fecundity of the married women of this country may probably be expressed accurately enough, if a correction be made . . . for the illegitimate children borne before and after marriage by women who marry . . ." [2] Two years later he gave for England (1842) 4·79 as the number of legitimate births for every *two* persons married (first married), 5·12 as the number of all births to every two persons married, and concluded: "as many illegitimate children are the offspring of married persons before, during, or after marriage, the number of children to every two persons married in England must be between 4·79 and 5·12 or little short of five . . ." [3] But in all subsequent reports he simply excluded all the illegitimate births, relating the legitimate births to all marriages, or married persons,[4] and we are not aware of any other author suggesting a differential treatment of illegitimate births according to the past, present, or future civil status of the mother.

[1] *Fourth Report* (1840–41), p. 136.
[2] *Ibid.*, p. 137.
[3] *Sixth Report* (1842), p. xxx.
[4] In the *Twenty-Seventh Report* (1864), p. xx, he even said that "the 740,275 births registered in the year 1864 must be divided by the marriages," although those 740,275 births included the illegitimate births, but in carrying out the division, he considered only the 692,827 legitimate births. In the *Thirty-First Report* (1868) he actually related the total births to the marriages.

A great deal of confusion on the whole has been created in this connection by the treatment of illegitimate births. We shall confine ourselves to one glaring example. According to the official French figures, there were in 1817–1823, 4·08 legitimate and 0·29 illegitimate births to one marriage. Quetelet, in 1827, said there were 4·08 legitimate and 0·68 illegitimate births; Smits, in 1827, said there were 4·08 legitimate and illegitimate births. Quetelet, in 1835, said there were 3·79 legitimate and 0·29 illegitimate births and repeated those figures in 1869. See Quetelet, A., *Recherches sur la population, les naissances*, etc., *dans le Royaume des Pays-Bas*, p. 8, Brussels, 1827; Smits, Édouard, *Statistique nationale*, pp. 43–44, Brussels, 1827; Quetelet, A., *Sur l'homme et le développement de ses facultés*, p. 80, Paris, 1835; Quetelet, Ad., *Physique sociale*, vol. i, p. 191, Brussels, 1869.

Since the ultimate object is to relate the births to the opportunities for child-bearing, the most satisfactory solution would seem to be to relate all births to the first cohabitations of females. The females concerned would be composed of four groups: (1) girls who never marry; (2) girls who marry another man than the partner of their first cohabitation; (3) girls who marry the partner of their first cohabitation (the cohabitation taking place before the planned marriage or the marriage being caused by pregnancy as a result of the cohabitation); (4) wives who have just got married. But this solution, of course, cannot be applied in practice, since the necessary data are nowhere available.

(3) Many methods have been used in order to eliminate the disturbing influence of the time factor which prevents the ratio of births to contemporaneous marriages from being an adequate measurement of fertility. A sound judgment of the merits of the various methods can only be reached if one realizes the two different ways in which the time factor works:

(*a*) If the birth rate and the marriage rate are constant, the ratio of the births to contemporaneous marriages will be unduly low in case the population increases, and unduly high in case the population decreases.

(*b*) If the birth rate and the marriage rate are not constant, the ratio of births to contemporaneous marriages will be unduly low when the ratio of the marriage rate to the birth rate increases, and unduly high when the ratio of the marriage rate to the birth rate decreases.

The errors arising from (*a*) and (*b*) will be cumulative if the population and the ratio of the marriage rate to the birth rate tend in the same direction; they may cancel out if the population and the ratio of the marriage rate to the birth rate move in opposite direction. The error arising from (*b*) may become smaller if a longer period is considered, while the error emanating from (*a*) is not likely to be affected by the length of the period.

Short (1750), as has been shown, sensed the error arising from a change in the ratio of the birth rate to the marriage rate

(*b*), but he was aware of only one specific case: the emigration of married people whose births after emigration appeared in the registers of another country.

Süssmilch (1761) drew attention to another case of this kind: he explained the apparently very high fertility in Prussia in 1756 by the drop in the number of marriages due to the outbreak of the Seven Years' War, and warned us against measuring fertility for such exceptional years.[1] But in saying that he should have excluded the year 1756 from his table, he showed that he did not realize the effect of the sudden drop in the number of marriages in that year on the number of births in the subsequent years. In so far as the marriages abandoned for 1756 were not consummated at all, the consequence would have been a reduction in the number of births for many years to come, and the ratio of births to marriages for all those years would have appeared unduly low. In so far as such marriages were merely postponed, the ratio of births to marriages for subsequent years would have been unduly high.

Price (1769), as has been shown, discovered the error resulting from an increase or decrease in population (*a*), but he suggested no remedy. The first to find the method, which in a primitive fashion was apt to eliminate the trouble caused by the time factor, was John Rickman (1802). In his report on the English census of 1801 he proposed to relate the births (baptisms) of one year to the average number of marriages of the same and the four preceding years:[2]

> . . . it is reasonable to assume, that the Marriages of any current Year, and of the Four preceding Years, must chiefly influence the Number of Baptisms in it.
>
> The medium Average of Marriages in 1760 and the Four Years preceding it, may be taken as 51,600; the Registered Baptisms of the same Year 1760 appear to have been 187,000; therefore the Registered Baptisms were at that Time as 362 to 100 Marriages.

[1] See *Die göttliche Ordnung*, 2nd ed., vol. i, p. 176, Berlin, 1761: "Das Jahr 1756 gab gar 61 Kinder von 10 Ehen. Allein dieses dienet nicht zum Beweise und solte weggeblieben seyn, weil durch den in selbigem Jahre entstandenen Krieg die Zahl der Ehen fast an Tausend verringert worden war, daher auf die geschlossenen mehr Kinder kommen musten."

[2] *Observations on the Results of the Population Act*, 41 Geo. III, p. 8.

Five years later (1807) Malthus, in the fourth edition of his *Essay on the Principle of Population*, explained in great detail the effect of the time factor in any comparison of births and marriages. He showed (*a*) that a comparison of births with contemporaneous marriages is apt to exaggerate the fluctuations in fertility; (*b*) how, in computing the fertility for a period, the births from marriages contracted before that period should be deducted and the births occurring after that period, but produced by marriages occurring during that period, should be added; (*c*) how, if the ratio of the birth rate to the marriage rate remains constant, fertility may be computed by relating the marriages of a single year to the births of a subsequent year.

(*a*) We can hardly indeed suppose, that the prolifickness of marriages should vary so much as the different proportions of births to marriages in the tables. Nor is it necessary that it should, as another cause will contribute to produce the same effect. The births which are contemporary with the marriages of any particular year belong principally to marriages which had taken place some years before; and therefore, if for four or five years a large proportion of marriages were to take place, and then accidentally for one or two years a small proportion, the effect would be a large proportion of births to marriages in the registers during these one or two years; and on the contrary, if for four or five years few marriages comparatively were to take place, and then for one or two years a great number, the effect would be a small proportion of births to marriages in the registers.[1]

(*b*) To form a judgment of the prolifickness of marriages, taken as they occur, including second and third marriages, let us cut off a certain period of the registers of any country, 30 years for instance, and inquire what is the number of births which have been produced by all the marriages included in the period cut off. It is evident, that with the marriages at the beginning of the period will be arranged a number of births proceeding from marriages not included in the period; and at the end, a number of births produced by the marriages included in the period will be found arranged with the marriages of a succeeding period. Now if we could subtract the former number, and add the latter, we should obtain exactly all the births produced by the marriages of the period, and of course the real prolifickness of those marriages. . . .

The average proportion of births to marriages in Europe is about 4 to 1. Let us suppose for the sake of illustration, that each marriage

[1] Malthus, *An Essay*, 4th ed., vol. i, pp. 551–552, London, 1807.

yields four children, one every other year. In this case it is evident, that wherever you begin your period in the registers, the marriages of the preceding eight years will only have produced half of their births, and the other half will be arranged with the marriages included in the period, and ought to be subtracted from them. In the same manner, the marriages of the last eight years of the period will only have produced half of their births, and the other half ought to be added. But half of the births of any eight years may be considered as nearly equal to all the births of the succeeding $3\frac{3}{4}$ years.* . . . Consequently if we subtract the births of the first $3\frac{3}{4}$ years of the period, and add the births of the $3\frac{3}{4}$ years subsequent to the period, we shall have a number of births nearly equal to the births produced by all the marriages included in the period, and of course the prolifickness of these marriages.[1]

(*c*) But if the population of a country be increasing regularly, and the births, deaths, and marriages continue always to bear the same proportion to each other, and to the whole population, it is evident, that all the births of any period will bear the same proportion to all the births of any other period of the same extent, taken a certain number of years later, as the births of any single year to the births of a single year taken the same number of years later; and the same will be true with regard to the marriages. And consequently to estimate the prolifickness of marriages, we have only to compare the marriages of the present or any other year, with the births of a subsequent year, taken $3\frac{3}{4}$ years later.

We have supposed in the present instance, that each marriage yields four births; but the average proportion of births to marriages in Europe is 4 to 1, and as the population of Europe is known to be increasing at present, the prolifickness of marriages must be greater than 4. If allowing for this circumstance, we take the distance of 4 years instead of $3\frac{3}{4}$ years, we shall probably be not far from the truth. And though undoubtedly the period will differ in different countries, yet it will not differ so much as we might at first imagine; because in countries where the marriages are more prolific, the births generally follow at shorter intervals, and where they are less prolific at longer intervals; and with different degrees of prolifickness, the length of the period might still remain the same.[2]

No doubt there are some weak points in Malthus' argument. And yet, had it attracted the attention it deserved, many blunders committed in the subsequent 130 years by official and private statisticians might have been avoided.

* According to the rate of increase which is now taking place in England, the period of calculation would be about $3\frac{3}{4}$ years.

[1] *Ibid.*, pp. 507–509.

[2] *Ibid.*, pp. 509–511.

Malthus had found the number of births to marriages in England to be 4. " The marriages compared with the births 4 years later will give 4·136 for the prolifickness of marriages.[1] Sadler (1830) considered this difference, which amounts to 3·4 per cent only, insignificant, and moreover condemned the principle applied by Malthus : [2]

But this mode of computation is not merely unnecessary for the purposes of comparison, it is inapplicable, excepting where the movements of the population exhibit great regularity, which is not often the case, more especially as it regards marriages : when there is any considerable or sudden fluctuation in the number of these, it will lead to errors far greater than those affected to be rectified. The reason of this, a little consideration will render plain. In the short average period of female prolificness, the first year after marriage is usually twice as fruitful, at the very least, as the ensuing ones . . . Any fluctuation, therefore, in the number of annual marriages has a very sensible effect on the births of the ensuing year . . . But the method now prescribed almost wholly omits this important consideration ; for, in dividing the births of any four following years by the marriages of other four preceding ones, it is obvious, that in only one year (the middle one) can the marriages and the births be consecutive : in the three others, the sudden influence that any considerable variation in the number of marriages has upon the register of the births, is totally omitted ; and this is often far greater than any which is produced during so short a term by the regular movement of the population. On this important consideration, the usual mode of estimating prolificness of marriages, more especially if calculated upon a sufficient number of years, is preferable, and, indeed, more exact.

He finally suggests as another alternative to relate the births to the marriages of the preceding year, a method which had already been used by Joshua Milne.[3]

If, then, any alteration in the general method of calculating the prolificness of marriages be deemed necessary, it must be by more closely connecting the marriages of any years under consideration, with their immediate results, instead of disconnecting and losing sight of the latter altogether. Hence, I am persuaded, that, in any given year, the number of its marriages, compared with its con-

[1] *Ibid.*, pp. 523–524.
[2] Sadler, *The Law of Population*, vol. ii, pp. 167–168.
[3] See Milne, Joshua, *A Treatise on the Valuation of Annuities and Assurances on Lives and Survivorships*, etc., vol. ii, pp. 389–392, London, 1815.

ceptions, or with the births that take place the year after, will, on the whole, be found to be a far better method of determining the question of prolificness than the one proposed.[1]

Bernoulli (1840) states that "the usual method of determining legitimate fertility or the average number of births to a marriage consists in dividing the number of legitimately born by the number of yearly marriages," but "since far the majority of children are brought into the world in the first 10 or 12 years of the marriage it would seem appropriate to consider the marriages of the period preceding by about five or six years." [2] He himself, however, was not of the opinion that the makeshift of choosing an earlier period for the marriages yields satisfactory results.[3]

Farr, in his first study (1842), merely mentioned that "the marriages increased 1 per cent. annually in the previous 14 years," and that a correction should "be made for the increase of marriages." [4] Two years later he divided the births "by the annual marriages that took place seven years before." [5] After three years more he computed fertility on the assumption that "the marriages 8 years before . . . may perhaps be taken to represent the number of marriages, of which . . . [present] births are the issue." [6] Still 18 years later he attempted to treat the time factor in a less haphazard fashion: [7]

As the age of the mothers is unfortunately not recorded, the interval in England is unknown which intervenes between the mean age of marriage and the mean age of the mothers when their children are born; otherwise that interval would indicate the calendar years with which the births of the year 1864 should be compared. But the interval in Sweden between the mean age of mothers at marriage (25·8 years) and their mean age at the births of their children (31·7) is six years; and the interval in England cannot differ much from

[1] Sadler, vol. ii, p. 171.
[2] Bernoulli, Christoph, *Populationistik oder Bevoelkerungswissenschaft*, Erste Haelfte, pp. 192–193, Ulm, 1840.
[3] See pp. 65–66, 68.
[4] *Fourth Report* (1840–41), p. 137.
[5] *Sixth Report* (1842), p. xxx.
[6] *Eighth Report* (1845), p. 3.
[7] *Twenty-Seventh Report* (1864), p. xx.

six years. Hence, if the legitimate births of given years are divided by the marriages of six years earlier date, the quotient will be the proportion of children to a marriage within close limits.

Farr from then on almost constantly related the births to the marriages contracted six years before,[1] and since this discovery of a six years' mean interval between marriage and birth has gained a world-wide fame,[2] it seems worth while to study the facts on which it is based.

Farr never stated the period to which his figures for Sweden refer, but since he said that the interval in England for 1864 " cannot differ much " from the interval in Sweden, it is to be supposed that he used the most recent Swedish statistics then available. Yet, the mean age of the mothers at the birth of legitimate children in Sweden exceeded 31·7 years in each quinquennial period since 1816–1820. Evidently, therefore, he took by mistake the age of all mothers (including mothers of illegitimate children) which in 1841–1850 was indeed 31·7 years. It is, however, impossible to understand how he could obtain a mean age of 25·8 years at marriage for 1841–1850. The official Swedish statistics show the mean age at marriage only from 1861 on. This age was 27·9 years in the decennial period 1861–1870 and, if one may judge from the percentage distribution of the age groups of marrying women, it should have exceeded 27 years also in 1841–1850.[3]

[1] See *Twenty-Eighth Report* (1865), p. xi ; *Thirtieth Report* (1867), pp. 222–223 ; *Thirty-Seventh Report* (1874), p. xiv ; *Fortieth Report* (1877), p. xxxvii. (In the *Thirty-First Report*, 1868, p. xxvii, however, he related the births to the marriages of the same year.)

[2] See, for instance, Lewis, C. J. and Lewis, J. Norman, *Natality and Fecundity ; A Contribution to National Demography*, p. 92, Edinburgh, 1906 : " The average number of children to a marriage is usually ascertained by dividing the annual number of births by the number of marriages in a preceding year. The marriages of the year immediately preceding were at first taken, but later Dr. Farr pointed out that a more accurate result would be arrived at by taking the number of marriages at a period of 6 years prior to the year in which the births occur. By this method the number of children to a marriage is stated in the returns of the Registrars-General for Great Britain." See also, for instance, Mayo-Smith, Richmond, *Statistics and Sociology*, p. 113, New York, 1910 : " Dr. Farr calculated that the interval between the mean age of mothers at marriage and their mean age at the births of their children is about six years. Hence, if the legitimate births of a given year be divided by the marriages of six years earlier date, the quotient will be the proportion of children to a marriage."

[1] See *Statistisk Tidskrift*, 1907, pp. 240, 280–281.

A perusal of the Swedish statistics for 1861–1930 shows that the " interval " in each decennial period was shorter than five years, and it seems that Farr was mistaken when he based the official English fertility statistics on the assumption that this " interval " was six years in Sweden.

Table 9.—Mean Age of Women at Marriage and at Legitimate Birth, Sweden, 1861–1930.[1]

Period	Mean Age of Women at Marriage	Mean Age of Mothers at Legitimate Birth	" Interval "
1861–1870	27·91	32·75	4·84
1871–1880	27·83	32·63	4·80
1881–1890	27·41	32·27	4·86
1891–1900	27·43	32·22	4·79
1901-1910	26·88	31·53	4·65
1911–1920	26·90	31·23	4·33
1921–1930	26·96	30·84	3·88

However, it should be mentioned in this connection that the difference between the mean age of mothers at birth and the mean age of women at marriage by no means indicates the mean interval between marriage and birth, the main reason being that women marrying late have fewer children than those marrying young. Let us assume that one-fifth of the women married at 20, and one-fifth each at 25, 30, 35, and 40. The mean age of women at marriage would then be 30 years. Let us further assume that the women marrying at 20 had children at 21, 23, 26, 29, and 32; that those marrying at 25 had children at 26, 28, 31, and 34; that those marrying at 30 had children at 31 and 33; that those marrying at 35 had a child at 36; and that those marrying at 40 had no child at all. The average age of mothers at birth would then be 29 years and 2 months, *i.e.* 10 months less than the average year at marriage!

Farr had computed the relation of births to marriages quite intermittently: for the years 1839–1845, 1862–1868, 1874, and 1876. His successors did not calculate this ratio,

[1] See *Statistisk Tidskrift*, 1907, p. 281; Sveriges Officiella Statistik, *Befolkningsrörelsen År* 1930, pp. 9*, 13*.

but they intimated that they would have chosen a shorter interval between births and marriages than six years, and they emphasized the strong influence of the marriages in the years immediately preceding the year of births. In his report for 1891, the Registrar-General stated : [1]

> The considerable rise [of the birth rate] . . . in 1891 . . . reflects doubtlessly the upward change in the marriage-rate which set in a year or two previously. For the main factor in determining the birth-rate is of course the marriage-rate ; not however the marriage-rate of the same or even of the next preceding year, but the combined rates of several preceding years.

Seventeen years later the Registrar-General again alluded to the ratio of the birth rate to the marriage rate : [2]

> One of the factors determining the birth-rate should be the marriage-rate, not the marriage-rate of the same or even the next preceding year, but the combined rates of several preceding years. An examination of the Tables, however, shows that it is somewhat difficult to trace over a long series of years a close correspondence between the two series of rates.

It must indeed be "somewhat difficult," because there cannot possibly be a close correspondence between the two series of *rates*. The close correspondence, observed in 1891, was merely an accident.

Year	Marriages	Births	Marriage rate	Birth rate
1885	197,745	894,270	14·5	32·9
1886	196,071	903,760	14·2	32·8
1887	200,518	886,331	14·4	31·9
1888	203,821	879,868	14·4	31·2
1889	213,865	885,944	15·0	31·1
1890	223,028	869,937	15·5	30·2
1891	226,526	914,157	15·6	31·4

It is obvious that a comparison of the rates completely masks what actually happens. Let us assume that 80 per cent of the marriages in three consecutive years give birth to a child in the fourth year—an assumption which certainly exaggerates

[1] *Fifty-Fourth Report* (1891), p. viii.
[2] *Seventy-First Report* (1908), p. xxv.

the influence of the number of recent marriages on births. The yearly change in the number of births due to the number of marriages in the three preceding years should then have been:

1889 + 4,861 ; but it was + 6,076
1890 + 14,235 ; but it was − 16,007
1891 + 18,008 ; but it was + 44,220

The considerable sudden increase of births in 1891 can then be explained only in a rather small measure by the increase of marriages in the preceding years. It lies outside the scope of this book to discuss the causes for an increase of marriages or births. But we may say here this much: if an improvement of economic conditions in a country is apt to increase at the same time the inclination to marry and the inclination to have children, it is apt to increase the number of births more than the number of marriages, since the number of births will increase not only as a consequence of the increase of marriages, but also on account of the greater inclination of all married couples to have children.

Ernst Kahn who, in his book on *The International Birth Strike* (1930), had related the births to the marriages of the same period states in a more recent article: [1]

> In a territory like the German Reich of to-day, one will come quite near the truth if one divides the birth rate of one year by the average of the marriage rates of the same and the three preceding years; if one wants to be particularly accurate, one may count twice the same and the immediately preceding year.

Quite apart from the mistake of relating the rates instead of the absolute figures in weighing the different calendar years, Kahn starts from a wrong assumption. Having found the great preponderance of births in the first year of marriage in Saxony, he considers the births in the calendar year of marriage as covering all the births in the first year of marriage, while actually only a small part of the births in the first year of marriage occur in the calendar year of marriage. Some countries (Hungary, 1897, Prussia and Italy since 1929) have classified the births by calendar year of marriage (see

[1] Kahn, "Zur Erkenntnis der Bevölkerungsbewegung," *Die Wirtschaftskurve*, 1931, p. 310.

Tables 10 and 11). It appears that in Prussia only 9·6 per cent of the total legitimate children born in 1930–1932 were the issue of marriages contracted in the year of birth. The percentages of births to marriages of the three preceding years were 18·4, 12·5, and 9·9, while 49·6 per cent were the offspring of earlier marriages. In Italy, 1930–1931, 4·5 per cent only were born in the year of marriage, and 65·0 were the issue of marriages concluded before 1927 or 1928.

TABLE 10.—LEGITIMATE BIRTHS [1] ACCORDING TO YEAR OF MARRIAGE.

Year of Marriage	Hungary 1897 [2]	Year of Marriage	Prussia [3]			Italy [4]	
			1930	1931	1932	1930	1931
1897	20,720	1932	—	—	55,215	—	—
1896	69,332	1931	—	55,484	100,447	—	44,220
1895	44,878	1930	60,558	107,528	69,191	49,551	150,692
1894	51,552	1929	118,559	73,784	56,592	148,351	80,983
1893	47,229	1928	78,868	59,232	46,719	84,905	78,460
1892	44,148	1927	59,608	45,664	36,624	89,328	70,163
1891	38,881	1926	45,792	35,522	28,043	76,199	64,589
1886–1890	161,640	1925	38,612	29,824	24,017	70,091	58,982
1881–1885	124,324	1924	30,193	23,134	18,503	65,118	54,927
1876–1880	65,178	1923	32,285	24,862	19,977	63,250	53,974
1871–1875	20,077	1922	32,639	25,195	20,387	64,421	54,155
1866–1870	2,466	1921	30,349	23,361	18,726	70,007	60,087
1861–1865	165	1920	31,411	24,187	19,327	78,588	66,016
1856–1860	52	1919	24,097	18,584	14,655	47,289	40,069
1851–1855	16	1918	8,066	5,949	4,787	13,519	11,304
1846–1850	3	1917	5,960	4,625	3,678	9,663	8,325
Unknown	5,291	1916	4,882	3,813	2,893	9,498	7,743
		1915	4,162	3,176	2,439	16,030	13,043
Total .	695,952	1914	5,833	4,281	3,326	21,489	17,227
		1913	5,993	4,181	3,098	19,924	15,846
		1912	4,927	3,579	2,449	17,376	13,252
		1911	3,801	2,756	1,799	13,848	10,988
		1910	3,118	2,001	1,300	12,522	9,240
		1909	2,143	1,355	795	9,275	6,712
		1908	1,611	973	522	7,819	5,341
		1907	1,066	631	349	5,071	3,272
		1906	623	373	185	3,525	2,160
		1905	395	227	106	2,389	1,326
		1904	231	116	55	1,446	739
		1903	110	75	18	768	371
		1902	47	48	18	434	185
		1901	31	44		259	100
		1900	24			97	49
		1899				36	21
		1898				16	8
		1897	6	47	3	2	2
		1896				4	4
		1895				—	1
		Unknown	3,617	4,388	3,073	3,256	3,246
		Total .	639,617	588,999	559,316	1,075,364	1,007,822

[1] Live- and still-born.
[2] See *Ungarische Statistische Mittheilungen*, New Series, vol. xxii, pp. 103*, 76.
[3] See *Zeitschrift des Preussischen Statistischen Landesamts*, vol. 71, pp. 50, 389; vol. 72, p. 103.
[4] See Istituto Centrale di Statistica del Regno d'Italia, *Movimento della popolazione secondo gli atti dello stato civile negli anni* 1929 *e* 1930, Parte I, *Introduzione*, pp. 148*–149*; *ibid.*, 1931, pp. 138–143.

TABLE 11.—LEGITIMATE BIRTHS [1] ACCORDING TO YEAR OF MARRIAGE.
(Per cent.)

Difference between Birth Year and Marriage Year	Hungary, 1897	Prussia, 1930–1932	Italy, 1930–1931
0	3·0	9·6	4·5
1	10·1	18·4	14·4
2	6·5	12·5	8·0
3	7·5	9·9	8·1
4	6·8	7·8	7·0
5	6·4	6·2	6·5
6	5·6	4·9	6·0
7	}	4·5	5·7
8	}	4·3	5·7
9	} 23·4	4·2	6·0
10	}	4·2	6·7
11	}	3·8	5·4
12	}	2·6	2·6
13	}	1·5	1·0
14	} 18·0	0·8	0·9
15	}	0·7	1·1
16	}	0·7	1·7
17	}	0·7	1·8
18	}	0·7	1·6
19	} 9·4	0·6	1·3
20	}	0·5	1·1
21	}	0·3	0·9
22	}	0·2	0·7
23	} 3·3	0·2	0·5
24	}	0·1	0·3
25 and more	}	0·1	0·5
Total	100·0	100·0	100·0

In view of the manifold methods used with the object of eliminating the time factor, it may be helpful to illustrate the results of such methods by a few fictitious examples. To facilitate a survey we shall assume that each 10 marrying women produced 40 children, 3 of whom were born in the calendar year of marriage, 6, 4, 3, and 3 in the subsequent four years, 2 in each of the six following years, and 1 in each of the nine following years.

We thus assume :

$$b_{20}=0{\cdot}1m_1+\ldots+0{\cdot}1m_9+0{\cdot}2m_{10}+\ldots+0{\cdot}2m_{15}+0{\cdot}3m_{16}+0{\cdot}3m_{17}+0{\cdot}4m_{18}+0{\cdot}6m_{19}+0{\cdot}3m_{20}$$

where b_{20} means the births of the calendar year 20 ;
m_1 means the marriages of the calendar year 1 ;
m_{20} means the marriages of the calendar year 20.

[1] Live- and still-born.

(1) If the number of yearly marriages is constant the ratio of births to marriages will always be 4:1, no matter whether one relates the births to the marriages of the same year or of other years.

(2) If the number of marriages increases every year by the same percentage the ratio of births to marriages will be the same in every calendar year, no matter what method is employed with a view of eliminating the time factor; but the ratio will vary according to the method employed. In case the marriages increase every year by 1 per cent the ratio of births to marriages will be 3·755 : 1 if one relates the births to the marriages of the same year; 3·793 : 1 if one relates the births to the marriages of the preceding year; 3·868 if one relates the births to the marriages of the same and the six preceding years; 3·983 if one relates the births to the marriages of the same and the twelve preceding years; 3·986 if one relates the births to the marriages of the sixth preceding year only. In all these cases the ratio of births to marriages makes fertility appear unduly low. But if one relates the births to the marriages of the same and the thirteen or more preceding years, or to the seventh preceding year or any earlier year, the ratio would exceed 4 : 1.

If the number of marriages changes, but not by always the same percentage, the ratio of births to marriages will vary in every calendar year, no matter which method is employed with a view of eliminating the time factor. If we assume that in the first calendar year under consideration the number of marriages was 810, and that it increases every year by ten with the exception of the years 8, 16, 24, 32, 40, 48, and 56, in which years it always drops to one-half of what it should have been, the results for every year from 20 to 59 are as shown in Table A. The corresponding results for quinquennial, decennial, twenty-year periods, and for the whole forty-year period are shown in Table B. The average ratios, the standard deviations, the coefficient of variation, and the percentage deviation from 4 in each series are shown in Table C.

As might be expected, the results of relating the births of one year to the marriages of the same or another individual year are most unsatisfactory. This is particularly true of the

ratio of the births to the marriages of the sixth preceding year. The results are much more satisfactory if one chooses a longer period than a year. But the best safeguard evidently is to

TABLE A.—RATIO OF BIRTHS TO MARRIAGES BY YEARS.

Calendar Year	Marriages	Births	Ratio of Births to Marriages of				
			Same Year	Preceding Year	Same and 6 preceding Years	Same and 12 preceding Years	Sixth preceding Year
20	1,000	3,552	3·552	3·588	3·940	4·086	3·779
21	1,010	3,640	3·604	3·640	3·994	3·987	3·832
22	1,020	3,680	3·608	3·644	3·994	3·987	7·667
23	1,030	3,720	3·612	3·647	3·720	3·987	3·835
24	520	3,604	6·931	3·499	3·852	3·991	3·678
25	1,050	3,488	*3·322*	6·708	*3·688*	*3·820*	*3·523*
26	1,060	3,632	3·426	*3·459*	3·800	3·935	3·632
27	1,070	3,772	3·525	3·558	3·906	4·043	3·735
28	1,080	3,856	3·570	3·604	3·952	4·089	3·780
29	1,090	3,948	3·622	3·656	4·005	3·988	3·833
30	1,100	3,988	3·625	3·659	4·005	3·988	7·669
31	1,110	4,028	3·629	3·662	3·730	3·988	3·836
32	560	3,900	6·964	3·514	3·861	3·992	3·679
33	1,130	3,772	3·338	6·736	3·698	3·822	3·525
34	1,140	3,924	3·442	3·473	3·810	3·936	3·633
35	1,150	4,072	3·541	3·572	3·915	4·044	3·736
36	1,160	4,160	3·586	3·617	3·962	4·091	3·782
37	1,170	4,256	3·638	3·669	4·015	3·989	3·834
38	1,180	4,296	3·641	3·672	4·015	3·989	7·671
39	1,190	4,336	3·644	3·675	3·738	3·989	3·838
40	600	4,196	6·993	3·526	3·870	3·993	3·681
41	1,210	4,056	3·352	6·760	3·707	3·824	3·527
42	1,220	4,216	3·456	3·484	3·818	3·937	3·634
43	1,230	4,372	3·554	3·584	3·924	4·045	3·737
44	1,240	4,464	3·600	3·629	3·971	4·093	3·783
45	1,250	4,564	3·651	3·681	4·024	3·990	3·835
46	1,260	4,604	3·654	3·683	4·023	3·990	7·673
47	1,270	4,644	3·657	3·686	3·745	3·990	3·838
48	640	4,492	7·019	3·537	3·877	3·994	3·682
49	1,290	4,340	3·364	6·781	3·714	3·825	3·528
50	1,300	4,508	3·468	3·495	3·825	3·938	3·635
51	1,310	4,672	3·566	3·594	3·931	4·046	3·738
52	1,320	4,768	3·612	3·640	3·978	*4·094*	3·784
53	1,330	4,872	3·663	3·691	*4·031*	3·991	3·836
54	1,340	4,912	3·666	3·693	4·031	3·991	*7·675*
55	1,350	4,952	3·668	3·696	3·750	3·991	3·839
56	680	4,788	*7·041*	3·547	3·883	3·995	3·683
57	1,370	4,624	3·375	*6·800*	3·720	3·826	3·530
58	1,380	4,800	3·478	3·504	3·831	3·939	3·636
59	1,390	4,972	3·577	3·603	3·937	4·047	3·738

TABLE B.—RATIO OF BIRTHS TO MARRIAGES BY PERIODS.

Calendar Years	Marriages	Births	Ratio of Births to Marriages of				
			Same Year	Preceding Year	Same and 6 preceding Years	Same and 12 preceding Years	Sixth preceding Year
Quinquennial Periods							
20–24	4,580	18,196	3·973	3·603	3·897	4·007	4·212
25–29	5,350	18,696	3·495	3·911	3·872	3·976	3·702
30–34	5,040	19,612	3·891	3·930	3·819	3·945	4·103
35–39	5,850	21,120	3·610	3·641	3·926	4·019	4·232
40–44	5,500	21,304	3·873	3·909	3·858	3·979	3·673
45–49	5,710	22,644	3·966	4·001	3·874	3·958	4·155
50–54	6,600	23,732	3·596	3·623	3·960	4·012	4·193
55–59	6,170	24,136	3·912	3·944	3·824	3·960	3·685
Decennial Periods							
20–29	9,930	36,892	3·715	3·753	3·884	3·991	3·937
30–39	10,890	40,732	3·740	3·775	3·873	3·983	4·169
40–49	11,210	43,948	3·920	3·956	3·866	3·968	3·906
50–59	12,770	47,868	3·748	3·778	3·890	3·986	3·920
Twenty-Year Periods							
20–39	20,820	77,624	3·729	3·765	3·878	3·987	4·056
40–59	23,980	91,816	3·823	3·861	3·879	3·977	3·914
Forty-Year Period							
20–59	44,800	169,440	3·782	3·816	3·879	3·982	3·977

TABLE C.—AVERAGE RATIO OF BIRTHS TO MARRIAGES AND DEVIATIONS.

Periods	Ratio of Births to Marriages of				
	Same Year	Preceding Year	Same and 6 preceding Years	Same and 12 preceding Years	Sixth preceding Year
Average Ratio of Births to Marriages					
Yearly . .	3·981	3·997	3·880	3·982	4·213
Quinquennial	3·789	3·781	3·879	3·982	3·994
Decennial .	3·781	3·815	3·878	3·982	3·983
Twenty years	3·779	3·813	3·879	3·982	3·985
Forty years .	3·782	3·816	3·879	3·982	3·977
Standard Deviation					
Yearly . .	±1·141	±1·046	±0·112	±0·074	±1·311
Quinquennial	±0·178	±0·156	±0·045	±0·026	±0·241
Decennial .	±0·081	±0·082	±0·009	±0·009	±0·108
Twenty years	±0·050	±0·048	±0·002	±0·005	±0·029

TABLE C.—AVERAGE RATIO OF BIRTHS TO MARRIAGES AND DEVIATIONS —*continued.*

Periods	Ratio of Births to Marriages of				
	Same Year	Preceding Year	Same and 6 preceding Years	Same and 12 preceding Years	Sixth preceding Year
	Coefficient of Variation				
Yearly . .	±28·7	±26·2	±2·9	±1·9	±31·1
Quinquennial	± 4·7	± 4·1	±1·2	±0·7	± 6·0
Decennial .	± 2·1	± 2·1	±0·2	±0·2	± 2·7
Twenty years	± 1·3	± 1·3	±0·01	±0·1	± 0·7
	Deviation Percentage of Average Ratio from 4				
Yearly .	−0·5	−0·1	−3·0	−0·5	+5·3
Quinquennial	−5·3	−5·5	−3·0	−0·4	−0·1
Decennial .	−5·5	−4·6	−3·0	−0·4	−0·4
Twenty years	−5·5	−4·7	−3·0	−0·4	−0·4
Forty years .	−5·5	−4·6	−3·0	−0·5	−0·6

relate the births to the marriages of the same and a large number of preceding years.

It may seem that we have chosen an illustration such as will never occur in practice, and that no one nowadays would think of relating births to marriages without taking such precautions as would minimize the effect of sudden changes in the number of marriages. But as a matter of fact, the oscillations in the number of marriages in the course of the last 20 years have been much more erratic in some countries than those which we have assumed in our example, and, in spite of this, statistical offices of a very high standing have related births to marriages without taking any precautions whatsoever. As an illustration, the results of a computation of international fertility recently published by the Hungarian Statistical Office may be cited (see Table 12, column 1). The comments of the Office read as follows : [1]

This computation of fertility of marriages is, to be sure, only an approximate statement, fit for a mutual comparison of the states rather than an exact index of the fertility of marriages of the respective

[1] *Publications statistiques Hongroises*, New Series, vol. 74, p. 75*.

TABLE 12.—RATIO OF LEGITIMATE BIRTHS IN 1923–1925 TO MARRIAGES IN 1923–1925.

Country	Ratio of Live- and Still-born to Marriages	Ratio of Live-born to Marriages	Ratio of Live-born to Marriages of Spinsters
Poland [1]	4·28	4·20	4·48
Irish Free State	4·12 [2]	4·12	4·27
Spain	3·99	3·88	4·06
Bulgaria	3·65 [3 4]	3·65	4·17
Rumania	3·57 [5]	3·52	—
Northern Ireland	3·56 [2]	3·56	3·74
Italy	3·48 [6]	3·46	3·61
Finland	3·30	3·22	3·45
Netherlands	3·29	3·19	3·37
Scotland	3·02 [2]	3·02	3·18
Hungary	2·89 [7]	2·82	3·27
Bavaria	2·84	2·76	3·00
Czechoslovakia	2·61	2·55	2·76
Wurttemberg	2·56	2·50	2·68
Latvia	2·55 [8]	2·52	—
Denmark	2·55	2·50	2·65
Switzerland	2·54	2·48	2·68
Sweden	2·50 [2 9]	2·49	2·59
England	2·38 [2]	2·38	2·57
Prussia	2·37	2·30	2·54
Germany	2·36	2·29	2·52
Luxemburg	2·32	2·24	2·40
Norway	2·28 [10]	3·26	3·41
Austria	2·16	2·09	—
Estonia	2·12	—	—
France	2·04	1·96	2·19
Belgium	1·96	1·87	—
Saxony	1·81	1·75	1·93

Sources : col. 1, for figures and footnotes 2, 3, 8, see *Publications statistiques Hongroises*, New Series, vol. 74, p. 74 ; cols. 2 and 3 computed from the official sources of the individual countries.

countries. The objections which might be raised against this method of computation apply equally to each state. It is evident, indeed, that with this method of computation part of the births do

[1] Western Provinces only.
[2] Live-born only.
[3] 1923–1924 only.
[4] For 1923–1925, 3·67.
[5] According to our computation, 3·58.
[6] According to our computation, 3·59.
[7] According to our computation, 2·90.
[8] 1924–1925 only.
[9] According to our computation, 2·49 ; for live- and still-born, 2·55.
[10] According to our computation, 3·33.

not result from the marriages related to those births. On the other hand, part of the marriages comprised in the comparison could not yet produce births. The two factors reduce the result of our computation. It is, however, incontestable that part of the marriages have ceased in the meantime as a consequence of divorce, death, etc., and this fact, or this neglected fact, enhances, on the other hand, the proportion thus computed. If the number of consummated marriages, for any reason, suddenly rises by bounds, as was the case after the war, for instance, in 1919 or 1920, fertility appears inferior to actual fertility as a consequence of the enhancement of the denominator. We, therefore, have carried out this comparison for the second, more recent period of our publication,[1] for the years 1923–1925, when the fever of contracting marriages was already appeased all over Europe.

In adding our own comment on the results of this compilation, we must distinguish between the errors due to the neglect of the time factor and all other errors. Taking first the latter:

(1) Some of the figures are wrong; in the case of Norway the births of two years were related to the marriages of three years; for Italy the birth figures do not refer to the same territory as the marriage figures. If these two figures are corrected, Italy takes the fifth rank instead of the seventh; Norway the eighth rank instead of the twenty-third.

(2) Most of the figures include still-born, but some comprise live-born only. In order to eliminate this incongruity we show in column 2 for every country the ratio of legitimate live-born to the marriages of the same years. Since the proportion of still-born is everywhere relatively small, the order of the countries is only slightly affected by this correction.

(3) We show finally in column 3 the ratio of legitimate live-born to the marriages of spinsters for every country for which data are available. The effect of this correction is quite noticeable, since the proportion of remarriages varies greatly from country to country. While the ratio of legitimate live-born to all marriages was, for instance, 4·12 in the Irish Free State and 3·65 in Bulgaria, the ratios of legitimate live-born to the marriages of spinsters were 4·27 and 4·17 respectively.

As regards the neglect of the time factor, it is impossible to

[1] The publication covers the period 1919–1925.

measure it accurately. But it is possible to convey an idea of the extent of the error by roughly weighing the total number of marriages which may have produced children in 1923–1925. Unfortunately the available data on remarriages are so scanty that we must confine ourselves to a computation of the ratio of the legitimate live-born to all marriages. Assuming then that all marriages in 1904–1925 were equally fruitful, and that they produced in the calendar year of their contraction $6\frac{2}{3}$ per cent of all their children, in the following year $16\frac{2}{3}$ per cent, in the subsequent four years 10, $8\frac{1}{3}$, $6\frac{2}{3}$, and $6\frac{2}{3}$ per cent, in the next four years 5 per cent each, for five more years $3\frac{1}{3}$ per cent each, and for five years more $1\frac{2}{3}$ per cent each, the ratio of legitimate live-born in 1923–1925 to the weighed number of marriages in 1904–1925 would be as indicated in Table 13, column 1.[1]

TABLE 13.—RATIO OF LEGITIMATE LIVE-BORN IN 1923–1925 TO MARRIAGES.

Country	Ratio to Marriages of		Country	Ratio to Marriages of	
	1904–1925	1923–1925		1904–1925	1923–1925
Spain	4·01	3·88	Sweden	2·55	2·49
Irish Free State	3·92	4·12	Switzerland	2·53	2·48
Italy	3·51	3·46	Luxemburg	2·49	2·24
Finland	3·48	3·22	Wurttemberg	2·36	2·50
Northern Ireland	3·47	3·56	England	2·31	2·38
Netherlands	3·36	3·19	Germany	2·16	2·29
Norway	3·25	3·26	Belgium	2·13	1·87
Scotland	2·84	3·02	France	2·02	1·96
Hungary	2·81	2·82	Austria	1·95	2·09
Czechoslovakia	2·76	2·55	Saxony	1·62	1·75
Denmark	2·68	2·50	Average	2·77	2·74

[1] To make the procedure still clearer: We have assumed that the 295,689 marriages contracted in England in 1925 produced $6\frac{2}{3}$ per cent of all their children, or 19,713·x children in 1925; that the 296,416 marriages of 1924 produced $6\frac{2}{3}$ per cent of all their children, or 19,761·x children in 1924, and $16\frac{2}{3}$ per cent, or 49,403·x children in 1925, etc. The total number of children produced in 1923–1925 by the marriages contracted in England in 1904–1925 would then amount to 913,352·x children. Since the actual number of legitimate live-born in 1923–1925 was 2,107,932, the ratio of legitimate live-born to the weighed number of marriages would be 2·31.

It is, first of all, interesting to note that the average ratio of births to weighed marriages (2·77) differs very little from the average ratio of births to the marriages of the same years (2·74). The assumption of the Hungarian Statistical Office that the neglect of the time factor makes fertility appear lower than it is, therefore, is wrong. Wrong, likewise, is the assumption of the office that the neglect of the time factor affects equally all countries. Actually it affects the various countries to a quite different extent. By eliminating the time factor the rates of the Irish Free State and Spain, which were 4·12 and 3·88, become 3·92 and 4·01 ; the rates of Northern Ireland and Finland, which were 3·56 and 3·22, become 3·47 and 3·48 ; the rates of Germany and Belgium, which were 2·29 and 1·87, become 2·16 and 2·13, etc. Nor, in view of the differing trend of marriages in the different countries, is there anything surprising in such changes.

Table 14 shows for each country the average number of

TABLE 14.—AVERAGE YEARLY MARRIAGES BY PERIODS, 1904–1925.

Country [1]	1904–1913	1914–1918	1919–1922	1923–1925	Lowest	Highest
Spain	139,153	136,429	167,935	158,301	128,269 (1915)	175,677 (1920)
Irish Free State	15,414	15,331	16,180	14,758	13,820 (1925)	17,276 (1920)
Italy	274,257	156,284	421,291	312,302	103,087 (1917)	530,073 (1920)
Finland	19,208	18,095	22,420	22,595	15,008 (1918)	23,719 (1921)
Northern Ireland	7,359	7,416	8,934	7,723	6,872 (1917)	9,992 (1919)
Netherlands	43,109	46,210	62,080	56,123	40,574 (1904)	65,325 (1920)
Norway	14,198	17,426	17,272	16,588	13,269 (1905)	20,019 (1918)
Scotland	32,062	33,526	41,108	33,328	30,108 (1909)	46,754 (1920)
Hungary	66,900	41,623	111,463	76,049	27,025 (1915)	160,550 (1919)
Czechoslovakia	104,000	62,500	167,559	129,126	46,000 (1916)	184,990 (1919)
Denmark	19,699	20,720	25,584	24,942	18,225 (1904)	26,991 (1920)
Sweden	32,529	35,061	39,891	37,544	30,683 (1904)	42,918 (1920)
Switzerland	27,168	22,679	32,103	28,727	19,527 (1915)	34,975 (1920)
Luxemburg	1,980	1,449	2,518	2,331	1,219 (1915)	2,874 (1920)
Wurttemberg	18,110	10,485	28,178	18,325	7,598 (1915)	32,027 (1920)
England	270,362	296,230	342,442	294,838	257,856 (1904)	379,982 (1920)
Germany	451,000	305,000	768,182	501,369	251,000 (1915)	871,973 (1920)
Belgium	58,568	34,548	93,715	78,081	24,654 (1915)	106,514 (1920)
France	320,505	159,600	503,884	354,432	86,000 (1915)	622,724 (1920)
Austria	49,453	35,904	80,432	53,427	28,398 (1916)	85,866 (1920)
Saxony	39,132	28,247	61,497	41,142	24,211 (1916)	71,545 (1920)

marriages in the pre-war decade 1904–1913, in the war years 1914–1918, in the post-war period 1919–1922, and in the three years 1923–1925. If the average of the last period is put equal to 100 (see Table 15), the average for 1904–1913 varied

[1] Present territory, but Belgium and Denmark pre-war territory.

TABLE 15.—AVERAGE YEARLY MARRIAGES BY PERIODS, 1904–1925. (1923–1925=100.)

Country	1904–1913	1914–1918	1919–1922	1923–1925	Lowest	Highest
Spain	88	86	106	100	81	111
Irish Free State	104	104	110	100	94	117
Italy	88	50	135	100	33	170
Finland	85	80	99	100	66	105
Northern Ireland	95	96	116	100	89	129
Netherlands	77	82	111	100	72	116
Norway	86	105	104	100	80	121
Scotland	96	101	123	100	90	140
Hungary	88	55	147	100	36	211
Czechoslovakia	81	48	130	100	36	143
Denmark	79	83	103	100	73	108
Sweden	87	93	106	100	82	114
Switzerland	95	79	112	100	68	122
Luxemburg	85	62	108	100	54	123
Wurttemberg	99	57	154	100	41	175
England	92	100	116	100	87	129
Germany	90	60	153	100	50	174
Belgium	75	44	120	100	32	136
France	90	45	142	100	24	176
Austria	93	67	151	100	53	161
Saxony	95	69	149	100	59	173

between 75 (Belgium) and 104 (Irish Free State), the average for 1914–1918 between 44 (Belgium) and 105 (Norway), and the average for 1919–1922 between 99 (Finland) and 154 (Wurttemberg). While the highest number for any year exceeded the lowest number for any year by not more than 25 per cent in the Irish Free State, 37 per cent in Spain, and 40 per cent in Sweden, this excess amounted to 414 per cent in Italy, 494 per cent in Hungary, and 624 per cent in France.

In the preceding example we have roughly weighed the number of marriages in 1904–1925 according to the probability of their having produced children in 1923–1925, in order to show the large margin of error involved in relating the number of births in 1923–1925 to the number of marriages in 1923–1925. Our object, of course, was not, and could not be, to ascertain the fertility which the marriages in 1904–1925 actually had in 1923–1925. But in the few cases where the births by year of marriage are known it is feasible to obtain

results which come much nearer to the truth by replacing the arbitrary percentages which we have chosen by percentages based on facts. This method of taking account of the time factor has recently been proposed by Corrado Gini (1932) in a study, published in his official report on the vital statistics of Italy, 1928.[1] The Italian Statistical Office, which Gini so ably directed up to 1932, as late as 1931 had computed fertility of marriages through the usual method, *i.e.* by relating the legitimate births to the marriages of the same year.[2] It summarized its activity in this field until 1932 in the following terms : [3]

In the volumes on vital statistics from 1872 to 1914, the mean number of children legitimately born to a marriage was ascertained by using the method of relating the number of legitimate live-born or of legitimate births (including the still-born) in a given year to the number of marriages consummated in the same year. This method is based on the double hypothesis : (1) that the number of marriages is the same in every year ; (2) that the fertility of the marriages with a certain duration remains on the whole constant.

The large reduction of marriages and births which occurred in the war years led to a suspension of this investigation which was resumed for the year 1924, since from that year on the number of marriages had returned to the normal rate.

In 1929, the office, for the first time, called attention to the fact that the ratio of births to contemporaneous marriages did not convey an adequate picture of fertility :

In the volume on the vital statistics for the year 1926,[4] and in that for the year 1927 [5] we have pointed out that in order to obtain with better approximation the mean number of children legitimately born to a marriage it would be more appropriate to relate the number of births in a given year to the number of marriages consummated in a year which precedes the one under examination by a period

[1] See *Movimento della popolazione secondo gli atti dello stato civile nell'anno* 1928, pp. *181–*191, Roma, 1932 ; see also Gini, " Di un procedimento per la determinazione del numero medio dei figli legittimi per matrimonio," *Metron*, vol. x, N. 1–2 (1932), pp. 3–31 ; Mortara, Giorgio, " Sui metodi per lo studio della fecondità dei matrimoni," *Giornale degli Economisti e Rivista di Statistica*, vol. lxxiii, Dicembre, 1933, pp. 890–897.

[2] See *Movimento*, 1927, p. *116, Roma, 1931.

[3] *Ibid.*, 1928, p. *109, Roma, 1932.

[4] See *ibid.*, 1926, p. *65, Roma, 1929.

[5] See *ibid.*, 1927, p. 115, Roma, 1931.

corresponding to the mean interval between the marriage and the birth of a child, which interval, according to the investigations made by Gini, amounted for Italy in the pre-war period to eight years.[1]

It was added that such a method could not be applied to the years 1926 and 1927 because it would have become necessary to relate the number of births in the said years to that of the marriages consummated in the years 1918 and 1919, which, as has been said, were exceptional with regard to nuptiality.

It may seem surprising that for many years Gini used such a fallacious method. But it certainly is not surprising that he finally came to the conclusion that fertility cannot be adequately shown by relating the births to the marriages of a single preceding year : [2]

The basis of this method may appear plausible, but in reality it is difficult to give any justification for it unless one recurs to an hypothesis which is very far from the truth.

He then proposed the method described above. We reproduce in Table 16 an extract from the results of his study.

This table shows that even for quadrennial periods the results are most unsatisfactory, no matter whether one relates the births to the marriages of the same year, or to those of the preceding year, or to those of the sixth preceding year, or to those of the eighth preceding year. However, the student should keep in mind that the more refined method of relating the births to a weighed average of all the marriages which can possibly have affected the number of births, conveys at best an approximate picture of actual fertility.[3]

We have so far discussed attempts at measuring the fertility of all married women by relating births to marriages. We shall now show some attempts made to measure in the same way (1) the fertility of fertile married women ; (2) the fertility of couples still in the reproductive period but not newly married.

(1) Thomas Short (1750) had already proposed to ascertain the fertility of fruitful marriages by relating the births to the number of fruitful marriages.

[1] Gini has included a most interesting study on the mean interval between marriage and birth in his well-known book *L'ammontare e la composizione della ricchezza delle nazioni*, pp. 52–58, 74–77, Torino, 1914.

[2] *Movimento della popolazione*, 1928, p. *183.

[3] See Chapter VI.

TABLE 16.—RATIO OF LEGITIMATE LIVE-BORN TO MARRIAGES, ITALY, 1903–1930.[1]

Years	Ratio to Marriages of				
	Same Year	Preceding Year	Sixth preceding Year	Eighth preceding Year	Weighed Years
1903	4·14	4·14	4·29	4·31	4·26
1904	4·14	4·32	4·67	4·61	4·42
1905	4·01	4·14	4·35	4·48	4·37
1906	3·89	3·96	4·36	4·62	4·27
1907	3·87	3·86	4·29	4·27	4·19
1908	3·82	4·16	4·56	4·65	4·45
1909	3·99	3·75	4·47	4·52	4·29
1910	4·04	4·08	4·39	4·58	4·36
1911	4·00	3·86	4·06	4·38	4·14
1912	4·08	4·15	4·14	4·36	4·28
1913	4·05	4·04	4·12	4·18	4·21
1914	4·21	4·02	3·75	4·07	4·16
1915	5·71	4·21	3·98	4·08	4·22
1916	7·98	4·55	3·14	2·98	3·54
1917	6·87	6·42	2·61	2·55	3·07
1918	5·81	6·30	2·35	2·32	2·99
1919	2·21	6·86	2·78	2·83	3·54
1920	2·17	3·32	4·38	4·17	4·65
1921	2·50	2·09	5·73	4·03	3·95
1922	3·07	2·53	10·17	4·27	3·84
1923	3·30	3·02	10·70	5·70	3·73
1924	3·49	3·20	9·59	9·70	3·60
1925	3·57	3·44	3·05	10·24	3·55
1926	3·52	3·52	1·97	9·33	3·51
1927	3·43	3·51	2·34	3·00	3·50
1928	3·57	3·37	2·79	1·92	3·42
1929	3·42	3·45	2·94	2·22	3·32
1930	3·45	3·61	3·39	2·85	3·51
1903–1906	4·04	4·14	4·41	4·50	4·33
1907–1910	3·93	3·96	4·43	4·51	4·32
1911–1914	4·08	4·02	4·01	4·24	4·20
1915–1918	6·45	4·99	3·03	2·97	3·49
1919–1922	2·46	2·90	4·93	3·82	4·00
1923–1926	3·46	3·28	3·91	8·23	3·59
1927–1930	3·47	3·48	2·81	2·42	3·44

Again, to find out how many Births fall to each prolifick Marriage, substract from the Weddings the Number or Proportion of barren, impotent, or improlifick Pairs from the prolifick, which will greatly add to the Number of Children begotten in fruitful Wedlock.[2]

[1] See *Movimento della popolazione secondo gli atti dello stato civile nell'anno* 1928, pp. *189–*190.

[2] Short, *New Observations*, p. 35. See also the same, *A Comparative History of the Increase and Decrease of Mankind in England, and several Countries Abroad*, pp. 52–53, 58, London, 1767.

William Farr tried in a similar way to measure the fertility of fertile wives, and therefrom to compute the number of first-born : [1]

> How can we determine the number of firstborn children in England annually ? It must evidently bear some relation to the marriages. Now the annual number of legitimate children in the six years 1862–67 was 695,597, and the annual marriages in the six years 1856–61, with which they may be fairly compared, were 162,681, of which 147,804 were marriages of spinsters : so that the births to a marriage are 4·276 ; the births to each woman married are 4·706. The births to each procreant wife—if only 133,024, or *nine* in *ten* wives, have living children—must be 5·229. Consequently as families consist of one, two, three, four, up to ten or more children, and every family has one firstborn child, it is evident that the first-born children in wedlock will be to the total children so born as 133,024 to 695,597 ; or as 1 to 5·229. We can from these proportions infer that about 19 per cent. of the children in wedlock are firstborn ; but, to get the number of women bearing first children, the mothers of the children born out of wedlock must be brought into account, and some corrections must be made.

He then assumes that two-thirds of the 46,181 children born out of wedlock in 1862–1867, or 30,788, were first-born and obtains 163,812 as total number of first-born children.[2]

(2) Sadler (1830) believed he had discovered a method of measuring the fertility of the married couples still in the reproductive period, but not newly married. He assumes that three-fourths of the marriages " produce a birth each before the termination of the year following that in which they take place," and that the average duration of matrimonial fertility is 11 years. He then deducts from the total number of births a number equal to three-fourths of the marriages of the preceding year, and relates the remainder of the births to the number of marriages in the first 10 years. If then there were 684,087 marriages in 1780–1789, 70,648 marriages in 1790, and 255,508 births in 1791, he assumes that 52,986 of those births were produced by the 70,648 marriages contracted in 1790 and 202,522 by the 684,087 marriages of 1780–1789. The fertility of the married couples still in the

[1] *Thirtieth Report* (1867), pp. 222–223.
[2] See *ibid.*, p. 226.

reproductive period but not newly married, would then have been 2·960 in 1790.[1]

Having shown the fallacy of each method of ascertaining fertility by relating births to marriages, it does not seem necessary to discuss in detail the mistakes made by Farr and Sadler. It may only be mentioned incidentally that since many mothers of illegitimate children appear, later in life, as mothers of other, legitimate, children it is not permissible to add the mothers of first-born legitimate and of first-born illegitimate children. The number of first-born legitimate children appears much smaller than it actually is, since the first-born child of a marriage through which a child has been legitimised is registered as second-born child.[2]

2. Ratio of Births to Dissolved Marriages

The fact that the ratio of births to marriages cannot convey an adequate picture of fertility even if the time factor is fully allowed for, led Bernoulli (1840) to study the ratio of births to dissolved marriages. His argument runs as follows : [3]

Since by far the most children are born in the first 10 or 12 years of wedlock, it would seem appropriate to relate the births to the marriages of a period five or six years earlier. In Prussia the ratio of births in 1835–1837 (508,700) to marriages in the same years (125,800) was 4·04 : 1, while the ratio of those births to marriages in 1829–1831 (106,000) was 4·8 : 1. The first ratio evidently makes fertility appear too low; but the second ratio probably makes fertility appear too high, because marriages have increased to an extraordinary degree since 1831. On the other hand, the ratio of births in 1835–1837 to marriages dissolved in the same years (100,000) evidently makes fertility appear too high. A more correct method of determining fertility would be to relate the double number of births to the sum of the marriages contracted and the marriages dissolved in the same years. Fertility in

[1] See Sadler, *The Law of Population*, vol. ii, pp. 245–249.
[2] See Chapter I, p. 22.
[3] See Bernoulli, Christoph, *Populationistik oder Bevoelkerungswissenschaft*, Erste Haelfte, pp. 193–194, Ulm, 1840.

Prussia would thus be $\frac{2\times5{,}087}{1{,}258+1{,}000}=4{\cdot}5$. But since the date of the dissolution of marriages is much more remote from the peak of fertility than the date of the consummation of marriages it would be preferable to give to the contracted marriages twice or rather three times the weight given to the dissolved marriages. Fertility in Prussia would then appear to be $\frac{3\times5{,}087}{2{,}516+1{,}000}$, or rather $\frac{4\times5{,}087}{3{,}774+1{,}000}=4{\cdot}25$.

Wappaeus (1861) likewise started from the assumption that by far the majority of legitimate children are born in the first 10 or 12 years of marriage, and that fertility must be derived from the ratio of births to the average number of contracted and dissolved marriages. But the solution he offers is not as logical as that of Bernoulli. He proposes (*a*) to divide the average number of legitimate births in a three-year period by the average number of marriages contracted in the preceding seven-year period; (*b*) to divide the same average number of legitimate births by the average number of marriages contracted and dissolved in the preceding seven-year period. He considers, however, the results of (*a*) too low and the results of (*b*) somewhat too high, because in the case of (*b*) it would have been more accurate to relate the legitimate births of one period to the average number of marriages contracted and dissolved in the same period. His final proposal, therefore, is to take the average of (*a*) and (*b*) as representing the fertility of marriages.[1]

In the programme of discussion for the preparatory congress to the seventh session of the International Statistical Congress (1869), the advisability of relating the births to the average number of contracted and dissolved marriages was raised again:[2]

> In several statistical documents fertility of marriages is measured by dividing for each year or for a series of years the legitimate births by the contracted marriages.
>
> There exists no identity at all between these relations. The

[1] See Wappaeus, *Allgemeine Bevölkerungsstatistik*, vol. 2, pp. 313–315, 375–378, Leipzig, 1861.

[2] *Projet de discussions pour l'avant-congrès*, p. 9.

births indicate the fertility of women at child-bearing age. The legitimate births of a given year are the fruit of marriages contracted in a series of preceding years.

It is, therefore, asked :

(1) For the countries which possess regular and periodical censuses of the population by age and by civil status, whether one should not compare the average of the legitimate births during a series of years with the mean married female population of child-bearing age during those years ? What are in the different countries the extreme limits of that age ?

(2) For the countries where the above censuses are lacking, whether the method or rather the expedient recommended by two eminent statisticians, Messrs. Ch. Bernoulli (*Handbuch der Populationistik*, p. 193, Ulm, 1841) and J. E. Wappaeus (*Allgemeine Bevölkerungsstatistik*, vol. ii, p. 314), of dividing the births by half the sum of the contracted and the dissolved marriages may be taken into consideration ?

The first question was rather fully discussed at the Congress,[1] but no reference whatsoever was made to the second question. One year later, however, Kollmann, the director of the Statistical Bureau of the Grand Duchy of Oldenburg, quite rightly answered the question in the negative. Having found that the number of legitimate births in the Grand Duchy (1855–1864) was 3·72 per contracted marriage and 4·58 per dissolved marriage, he concluded : [2]

These two quotients constitute respectively the minimum and the maximum limit. The true value must lie between the two limits, but whether more towards the one or the other side cannot be decided. The average of the two limits or the quotient of the division of the average number of yearly born legitimate children by half the sum of the average yearly contracted and dissolved marriages, therefore, is unsafe as an expression of the average number of children per marriage, and it is the more unsafe the greater the margin between the two limits mentioned above, and this margin is regularly the greater the more the population increases.

3. Number of Births per Married Woman Derived from Number of Births to Dissolved Marriages

A third method of measuring fertility by the exclusive use of vital statistics involves ascertaining the number of births to

[1] See Chapter IV.

[2] *Statistische Nachrichten ueber das Grossherzogtum Oldenburg*, Elftes Heft, p. 205, Oldenburg, 1870.

married couples at the date of the dissolution of their marriage. The first to call attention to this device was Christoph Bernoulli (1840). After having shown that legitimate fertility is usually computed indirectly (ratio of births to married couples or to marriages) he states : [1]

> It might be obtained more directly, it is true, through a control of all marriages dissolved (by death or divorce) and of the children born to each such marriage ; and such lists may show still further special details. Such registers, however, would hardly be very reliable, and it could hardly be avoided that children illegitimately born or only legitimised later would often be entered ; or that still-born, etc., be left out. Moreover, such registers are kept nowhere at present.

This method was first applied in Alsace-Lorraine, where, upon the suggestion of Richard Böckh, from 1872 on, the registration officers had asked in the case of each deceased husband and wife the " number of children born during the last marriage." The well-known economist, Wilhelm Stieda, who analysed the first results of this inquiry stated : [2]

> That this method . . . is the most exact and to be sure the only one which provides a sure record of the number of children of a marriage cannot be denied by anyone. We have here, indeed, for the first time the real fertility rate of a marriage, because we consider the marriages at the moment when their fertility is exhausted. This, of course, grants our figures a greater trustworthiness as compared with all the other computations which often are based on very improbable probabilities.

But apart from this single study for Alsace-Lorraine, and another one for Oldenburg (1876–1885), this method apparently has been applied nowhere before the beginning of the twentieth century. It might have fallen definitely into oblivion (like the method of ascertaining fertility by relating the births to the number of dissolved marriages) if it had not been revived 30 years ago by the statistical office of Hungary.

The method was introduced in Hungary in 1903, and has since been used in that country without interruption. The

[1] *Populationistik*, Erste Haelfte, p. 192.

[2] *Statistische Mittheilungen ueber Elsass-Lothringen*, Fuenftes Heft, pp. 62–63, Strasburg, 1875.

basic data were secured by ascertaining at the death registration of each married person the date of the marriage and the number of births to the marriage.[1] For one year (1903) the office computed fertility both of the deceased husbands and wives, but since it found the results for the husbands to "differ only very little" from the results for the wives, and since in case of the death of the husband there may be posthumous children, the office confined itself in later years to a consideration of the wives.[2]

An appraisal of the merits of this method will best be obtained by studying the actual results in Hungary. We shall, however, in analysing the results, exclude the figures for Croatia-Slavonia, since the data there furnished at death registration were evidently inadequate, especially for the earlier years.[3]

The last column of Table 17 shows the total number of marriages dissolved by the death of the wife. This number varied for the pre-war territory of Hungary proper between 43,773 (1903) and 67,033 (1918), the maximum being, however, 51,642 (1905) if the influenza-year 1918 is left out of

[1] See *Publications statistiques Hongroises*, New Series, vol. 7, p. 48*.

[2] See *ibid.*, vol. 22, p. 28*. As a matter of fact the figures for deceased husbands and wives may differ widely. We have compiled from the *Official Year Books of the Commonwealth of Australia*, 1910–1933, the following data on the average issue:

Year	Husband	Wife	Year	Husband	Wife	Year	Husband	Wife
1908*	5·42	5·23	1917	5·14	5·20	1926	4·70	4·93
1909*	5·38	5·20	1918	5·23	5·25	1927	4·60	4·86
1910*	5·46	5·33	1919	4·71	4·99	1928	4·57	4·84
1911	5·42	5·35	1920	5·07	5·17	1929	4·57	4·84
1912	5·36	5·29	1921	4·97	5·05	1930	4·49	4·70
1913	5·23	5·19	1922	4·93	5·10	1931	4·44	4·72
1914	5·26	5·29	1923	4·91	5·12	1932	4·39	4·70
1915	5·24	5·23	1924	4·80	4·98			
1916	5·23	5·16	1925	4·76	4·97	* excl. Tasmania		

It appears that while in the earlier years the average issue of the deceased husbands exceeded that of the deceased wives the reverse was true in every single year since 1916. The decrease in the average issue was much stronger for the husbands than for the wives: the average issue of the husbands dropped from 5·42 in 1908 to 4·39 in 1932, or by 19 per cent; the average issue of the wives dropped from 5·23 to 4·70, or by 10 per cent.

[3] See Chapter I, pp. 29–32.

TABLE 17.—MARRIAGES DISSOLVED BY DEATH OF WIFE ACCORDING TO DURATION, HUNGARY, 1903–1925.[1]

Year	Duration of Marriage in Years				Total
	Less than 5	5–9	10–19	20 and more	
1903	5,968	5,035	9,669	23,101	43,773
1904	6,298	5,357	9,952	25,127	46,734
1905	7,142	6,007	10,718	27,775	51,642
1906	6,412	5,530	9,307	24,706	45,955
1907	6,348	5,667	9,573	26,031	47,619
1908	6,434	5,542	9,413	26,129	47,518
1909	6,637	5,472	9,124	26,146	47,379
1910	6,238	5,105	8,423	25,335	45,101
1911	6,114	5,093	8,774	27,472	47,453
1912	5,874	4,929	8,248	26,507	45,558
1913	5,440	5,153	8,315	26,041	44,949
1914	5,724	5,527	8,476	25,957	45,684
1915	5,744	5,588	8,987	29,505	49,824
1916	4,638	5,464	8,834	27,847	46,783
1917	4,066	5,444	9,015	29,394	47,919
1918	6,786	9,994	14,605	35,648	67,033
1919	1,736	2,153	3,519	10,537	17,945
1920	2,540	2,006	3,461	10,379	18,386
1921	2,382	1,501	2,914	9,903	16,700
1922	2,864	1,264	2,878	9,674	16,680
1923	3,021	1,215	2,980	10,127	17,343
1924	2,951	1,574	3,035	10,750	18,310
1925	2,219	1,794	2,720	9,845	16,578

consideration; for the present territory of Hungary that number varied between 16,578 (1925) and 18,386 (1920). Since the total number of married women averaged about 3·6 million for 1903–1918 and about 1·7 million for 1919–1925, those fertility statistics included every year only about 1 or 1·5 per cent of all married women. The Hungarian Office itself called attention to the fact that "these statistics are only representative statistics."[2] But the sample, of course, is not chosen at random, since the average age of the women at death is, on the whole, much higher than the average age of all married women. Again, the wives who die before their

[1] See vol. 22, pp. 703, 707, 711; vol. 32, pp. 703, 707, 711; vol. 50, pp. 825, 829, 833, 837; vol. 70, p. 123; vol. 74, pp. 193, 195, 197. The figures for 1903–1918 refer to Hungary proper, those for 1919–1925 to present Hungary.

[2] Vol. 22, p. 28*.

husbands may, on the whole, have a lesser vitality than the average of all married women, and may therefore be less fruitful.

The last column of Table 19 shows the average number of children born to the deceased married women. It decreased from 4·22 in 1903 to 4·10 in 1905, oscillated between 4·04 and 4·13 from 1905 to 1917, dropped to 3·96 in 1918, was exactly as high in 1919 in the much reduced territory, and oscillated between 3·82 and 3·89 from 1920 to 1925. The lowest average was not quite 10 per cent smaller than the highest, and the average of 1925 was by only 4 per cent lower than in 1906–1910.[1]

However, it would be a big mistake to conclude from this that fertility of married women has hardly decreased at all in Hungary. Even if the wives deceased before their husbands could be considered as a whole to be true representatives of all married women, the average number of their children would not necessarily be a true indicator of their fertility, since the duration of marriage of the deceased may have undergone considerable changes. Indeed, variations from year to year were quite conspicuous (see Table 18). The proportion of the deceased wives who had been married for less than five years varied between 8·5 per cent (1917) and 17·4 per cent (1923); the proportion of those married from 5 to 9 years varied between 7·0 per cent (1923) and 14·9 per cent (1918); the proportion of those married from 10 to 19 years between 16·4 per cent (1925) and 22·1 per cent (1903); the proportion of those married over 20 years between 53·2 per cent (1918) and 61·3 per cent (1917). Compared with 1913, the medium groups (5 to 19 years) were sparsely represented in 1925, but the older group more amply.

If the deceased wives are grouped according to the duration of their marriage, the trend of the average number of children shows quite a different picture, at least, for the medium groups. The average number of children born to the deceased wives whose marriage had lasted from 5 to 9 years decreased

[1] Were it possible to compute for 1906–1910 the average for the post-war territory there might appear no decrease at all, since fertility in the ceded territories was particularly large (see vol. 74, p. 73*).

TABLE 18.—MARRIAGES DISSOLVED BY DEATH OF WIFE ACCORDING TO DURATION, HUNGARY, 1903–1925.
(Per cent.)

Years	Duration of Marriage in Years			
	Less than 5	5–9	10–19	20 and more
1903–1914	13·3	11·5	19·7	55·5
1915	11·5	11·2	18·1	59·2
1916	9·9	11·7	18·9	59·5
1917	8·5	11·4	18·8	61·3
1918	10·1	14·9	21·8	53·2
1919	9·7	12·0	19·6	58·7
1920–1924	15·7	8·6	17·5	58·2
1925	13·4	10·8	16·4	59·4

TABLE 19.—AVERAGE NUMBER OF BIRTHS PER MARRIAGE DISSOLVED BY DEATH OF WIFE ACCORDING TO DURATION OF MARRIAGE, HUNGARY, 1903–1925.[1]

Years	Duration of Marriage in Years				Total
	Less than 5	5–9	10–19	20 and more	
1903	1·13	2·54	4·15	5·41	4·22
1904	1·10	2·55	4·11	5·29	4·16
1905	1·08	2·49	3·99	5·27	4·10
1906	1·05	2·42	4·03	5·23	4·06
1907	1·03	2·44	3·92	5·21	4·06
1908	1·03	2·40	3·94	5·21	4·07
1909	1·02	2·41	3·86	5·20	4·04
1910	1·05	2·36	3·82	5·22	4·06
1911	1·03	2·37	3·85	5·24	4·13
1912	1·05	2·38	3·78	5·17	4·09
1913	1·03	2·40	3·85	5·15	4·10
1914	1·01	2·36	3·80	5·16	4·05
1915	1·08	2·33	3·71	5·10	4·07
1916	1·05	2·20	3·58	5·13	4·09
1917	1·04	2·06	3·50	5·08	4·09
1918	0·90	2·10	3·59	5·21	3·96
1919	0·74	2·01	3·49	5·06	3·96
1920	0·75	2·11	3·48	5·11	3·87
1921	0·79	1·99	3·33	5·07	3·88
1922	0·95	2·03	3·31	5·07	3·83
1923	1·02	1·91	3·26	5·04	3·82
1924	1·06	1·86	3·23	5·11	3·87
1925	1·02	1·87	3·24	5·09	3·89

[1] Computed from data given on the pages quoted in the footnote to Table 17.

from 2·54 or 2·55 in 1903–1904 to 2·49 in 1905, oscillated between 2·37 and 2·44 in 1906–1913, decreased to 2·20 in 1916, oscillated between 1·99 and 2·11 in 1917–1922, and decreased to 1·86 or 1·87 in 1924–1925. The decrease was almost as large for the women who had been married from 10 to 19 years; the average number of their children decreased in this case in a more conspicuous way in pre-war times, and this decrease went on during and after the war so that the average was only 3·23 or 3·24 in 1924–1925 as against 4·15 in 1903.

In the average number of children born to the deceased wives whose marriage had lasted less than five years there was no marked trend: from 1918 to 1922 the average, it is true, was very low (0·74 to 0·95), but in 1923–1925 (1·02 or 1·06) it was about as high as in 1905–1917 (1·01 to 1·08). Not much attention, however, should be paid to the number of children in this group because it includes, indiscriminately, wives who died shortly after marriage and those who died almost five years after marriage. For one year (1905) the Hungarian Office published the figures separately for the wives who had been married less than one year and those who had been married from one to four years. The average for the first group was 0·47, and for the latter 1·21 children.[1] The trend of the average number of children to deceased wives whose marriage has lasted less than five years may then be seriously affected by the varying proportion of those who have been married less than one year.

The most important group, of course, are the deceased wives who had been married for more than 20 years, since they constituted in each year the majority of the deceased wives. But, as in the case of women with the shortest duration of marriage, there was no marked trend in the average number of their children. Indeed, this group shows by far the least variations: the average decreased from 5·41 in 1903 to 5·27 in 1905, and oscillated between 5·04 and 5·24 in 1906–1925.

This result seems the more significant, as the deceased wives whose marriage had lasted more than 20 years are a rather

[1] See vol. 22, p. 747.

homogeneous group. Practically all of them have passed the child-bearing period, and the number of their children will have been less affected by lower vitality than that of the wives of all other groups. But what does the fact of their steady fertility prove ? It merely proves that the wives who died in 1925, after having married any year before 1906, were about as fertile as the wives who died in 1905, after having married any year before 1886.

A study of the number of children born to deceased wives cannot, therefore, give an adequate picture of fertility of marriages. The wives who die before having passed the child-bearing period are not very numerous and may have less fecundity than those who live longer. The wives who die after having passed the child-bearing period, on the other hand, have begun to bear children in a remote and ill-defined past. Moreover, this investigation covers only the last marriage and neglects the children born to the married women in former marriages.

Up to 1903 the Hungarian Statistical Office had ascertained fertility by deriving the number of children born to a marriage from the order of births. The reasons why it abandoned this procedure were given as follows : [1]

> The greatest defect of the data collected through this procedure is that the observations do not refer to marriages already sterile, but to marriages still fecund. It, therefore, is possible to establish by means of such data the true fertility of the marriages or the average number of children per marriage only after a relatively longer space of time, for instance, after 30 years, *i.e.* when the reproductive capacity of the marriages concluded in a certain period can be considered definitely closed. . . .
>
> The average fertility of the marriages can be established fairly accurately only through questions appearing on the death schedules of the deceased married persons. In adopting this procedure, the statistical observation covers only marriages definitely terminated, *i.e.* with regard to which a later birth is wholly excluded.

It is hard to see how it would be possible to derive from the order of births the average total number of children per

[1] Vol. 22, p. 27*.

marriage after a lapse of 30 years. It is likewise wrong to assume that the number of births to the deceased wives could possibly show the " true fertility " either for the present or for any definite past period.

Quite apart from this defect, the method of deriving fertility from the number of children born to deceased wives is erroneous. Forty-five years ago Richard Böckh had rejected it in the following terms : [1]

> This computation is worthless and misleading in ascertaining the fertility rate ; because it is as wrong to attempt to derive the number of children from the dissolved marriages as if one attempted to ascertain the duration of life by dividing the age of the deceased by their total number.[2]

4. Number of Births per Fruitful Married Woman derived from Order of Births

Several statisticians have attempted to derive the average number of children to a fruitful marriage from the order of births. The first to do so was James Stark (1861) in his well-known first registration report for Scotland.[3] Having ascertained that in Edinburgh during 1855 989 married women had their first confinement, 679 their second (and, therefore, altogether 1,358), etc., he concluded :

> The 4,208 mothers had among them 15,709 children, thus giving to each mother 3·7 children ; in other words, showing the fecundity of the women of Edinburgh to be 3·7 children for every fruitful Marriage.

The same method has been applied by J. Matthews Duncan (1866) to Edinburgh and Glasgow, 1855,[4] and by C. J. Lewis and J. Norman Lewis (1906) to Scotland, 1855.[5]

[1] Böckh, R., " Die statistische Messung der ehelichen Fruchtbarkeit," *Bulletin de l'institut international de statistique*, vol. v, 1890, pp. 165–166.

[2] The Hungarian Office, in 1924, stated that this method " of our compatriote Körösy has been adopted so to speak by the whole world " (vol. 70, p. 33*). This is fortunately an exaggeration. But it is true that this method is continuously used, for instance, in Australia and in Luxemburg.

[3] See *First Detailed Annual Report of the Registrar-General of Births, Deaths, and Marriages in Scotland*, pp. xix–xx, Edinburgh, 1861.

[4] See *Fecundity, Fertility, Sterility and Allied Topics*, 1st ed., pp. 113–115, Edinburgh, 1866 ; 2nd ed., pp. 116–118, Edinburgh, 1871.

[5] See *Natality and Fecundity*, p. 92.

In all these studies only the last-born child in case of plural births had been included. Franco Savorgnan, who recently (1933) applied the same method to the births in Italy, 1930,[1] rightly called attention to the fact that not only in case of plural, but also of single births only the last-born child within the calendar year should be included; but the cases when a mother has two deliveries within the same calendar year are numerically negligible.

The material published by Savorgnan would have permitted him further to improve this method by distinguishing between parents who had not had a legitimate child before their present marriage and those who had. If one carries out this distinction one finds that the 1,017,792 parents, where neither father nor mother had had a legitimate child before, gave birth to 3,515,528 or 3·45 each, while the 38,974 parents where either father or mother or both had a legitimate child gave birth in their present marriage to 129,656 children or 3·33 each. If one assumes, quite arbitrarily, that these 38,974 parents had had two children on an average in a former marriage the total number of children to the 1,056,766 parents would be 3,723,132 or 3·52.

Such small corrections, however, cannot eliminate the fundamental error inherent in a method which can lead to accurate results only if the number of marriages and of births remains constant. Since the number of marriages increased in the case of Scotland in the course of the twenty-year period ending 1855, the proportion of newly-married couples and, therefore, of first and second children, was disproportionally large in 1855. Probably, therefore, the actual number of children per fruitful marriage was larger than shown in the studies of Stark, Duncan, and the Lewis'. In the case of Italy, the trend of marriages and births in the course of the twenty-year period ending 1930 was so erratic that the order of births in 1930 bears practically no relation whatsoever to the fertility of fruitful marriages.[2]

[1] See *Movimento della popolazione secondo gli atti dello stato civile negli anni* 1929 *e* 1930, Parte I, *Introduzione*, pp. 113*–115*, Roma, 1933.

[2] See also the controversy between Gini and Savorgnan in *Bulletin de l'institut international de statistique*, vol. xxvii, 2, pp. 40–110.

Conclusion

When Graunt wanted to measure fertility of "a certain Parish in Hampshire" he had no other alternative but to divide births by marriages, since he did not know the age constitution of this population; but once censuses had been taken there was no longer a justification for using this method or any other method based on the exclusive use of vital statistics, since the intrinsic fallacy of all these methods cannot possibly be eliminated even by the most ingenious modifications.

CHAPTER III

MEASUREMENT OF FERTILITY BY EXCLUSIVE USE OF CENSUS STATISTICS

1. Married Women according to Number of Births

We have so far discussed some methods of measuring fertility based exclusively on the use of vital statistics (births and marriages, or births alone, or dissolved marriages). We shall now discuss some methods based exclusively on the use of census statistics. By far the most important method of the kind consists in ascertaining at the census for each married woman the number of children she has borne. This method, of course, can also be used in connection with enumerations which comprise only a specific group of people, and it has actually been used before censuses were taken.

The first to call attention to the possibility of ascertaining from the mothers the statistical data on all their children was Deparcieux (1746) : [1]

> There are few mothers who do not know the age of all their children, dead and living. One should therefore inquire from each mother the age of each of her living children and at what age the others died in case they have deceased ones.

But Deparcieux was interested only in computing the mean age of such children and did not relate the number of children to the number of mothers. Muret (1766) also started by using the method suggested by Deparcieux in order to find the mean age of the children in Vevey, Switzerland, but in the course of his studies realized the possibility of using the same data for the measurement of fertility : [2]

[1] Deparcieux, *Essai sur les probabilités de la durée de la vie humaine*, p. 66, Paris, 1746.

[2] Muret, *Mémoire sur l'état de la population dans le pays de Vaud*, p. 29, Yverdon, 1766.

In following this method, I found 32 years as the mean age of the considerable number of 2,093 children, all born in Vevey and issued from 375 mothers. I would have found a larger mean age if I had used a table of probabilities computed for our country; but I skip lightly this feature of mean age and, although it first was the unique object of my research, it is the least interesting of the discoveries to which this study has led me.

And first, since 375 mothers have yielded 2,093 live-born children, it results that each mother has brought into the world $5\frac{10}{12}$ [*sic.*]. I say each mother, and not, each marriage, which makes a great difference, because not every woman who marries has the privilege of becoming a mother, and because often a woman becomes mother from more than one marriage.

This method of measuring fertility has also been used, for instance, in 1848 in connection with an "investigation into the state of the poorer classes in St. George's in the East," carried on by the Statistical Society of London.[1] But the application which made this method world-famous was its use at the English Census of 1911.[2] On this occasion each married woman was asked the number of years her present marriage had lasted, and the number of children born alive to her present marriage, the latter to be subdivided into "children still living" and "children who have died." These data were combined with the age of the wife and the husband at the census and at marriage, the latter being found by deducting the duration of marriage from the age at census.

The main drawbacks of such an investigation of fertility are:

1. The basic material is apt to be somewhat inaccurate: many women will not report children who died shortly after birth.

2. The scope of the investigation is not all-inclusive. It does not include all mothers, since it excludes all those who at the time of the census were widowed or divorced. It does not even include all the legitimate children of the mothers

[1] See "Report to the Council of the Statistical Society of London from a Committee of its Fellows appointed to make an Investigation into the State of the Poorer Classes in St. George's in the East," *Journal of the Statistical Society of London*, vol. xi, 1848, pp. 194–195, 233.

[2] See *Census of England and Wales*, 1911, vol. xiii, *Fertility of Marriage*, Part I, 1917; Part II, 1923.

included in the investigation, since it excludes all children of former marriages.

3. Total fertility can only be ascertained for women who have passed the child-bearing period and who are still living and still married.

The fertility shown by such investigations thus refers to a remote and ill-defined past and cannot even be considered typical for this earlier period since it includes only children whose parents have survived up to the census.

Let us consider the rôle played by those drawbacks in connection with the English Census of 1911.

1. As to the inaccuracy of the basic data the Census Report states : [1]

> The general conclusion as to the validity of the data provided by the census inquiry for the study of fertility appears then to be that except for two errors in the record of duration of marriage—that of round numbers and that of misstatement of short durations—the material is generally satisfactory.

The tendency to concentration on round numbers—10, 20, 30, 40—was indeed even more pronounced in the case of marriage duration than in the statement of ages.[2] As to the misstatement of short durations, it appears from the fact that the ratio of married couples returned as married 0–1, 1–2, and 2–3 years to the number of marriages concluded in the three years preceding the census was 68, 85, and 89 per cent respectively, the enormous understatement of the number of couples returned as married under one year being mainly due to a desire of concealing antenuptial conception.[3]

An inaccuracy, however, which seems to us much more serious concerns the number of children born. According to the Census Report, 122,286 schedules have been rejected " owing to the particulars given in regard to duration of marriage or numbers of children being either defective or inconsistent with other stated facts." [4]

As a sample of the nature of the rejections those cases may be cited where apparently the instruction to return only the children of the

[1] *Ibid.*, vol. xiii, Part II, p. xi.
[2] See *ibid.*, Part II, pp. vii–viii.
[3] See *ibid.*, Part II, pp. vii–xi.
[4] *Ibid.*, Part I, p. 356.

existing marriage has been disregarded, *e.g.* in the case of a woman of 21 married for one year and returned as the mother of seven children, who were presumably born to the husband by a previous wife.[1]

It is unfortunate that the Registrar-General did not resist the temptation to attempt to eliminate cases where children born in a former marriage of wife or husband have been included. There is not the least doubt that the instruction to return only the children of the existing marriage has been frequently disregarded. But since this disregard became evident only when the duration of the existing marriage was comparatively short or when the age at marriage of the wife was very high, the elimination of such cases was necessarily restricted to specific groups. The figures, as published, do not afford a possibility of checking to what extent such arbitrary elimination of suspicious cases impairs a valid comparison of the numbers of children shown for marriages of short and of long duration, or for marriages in which the bride was young and where she was old. It is, however, possible to group the 122,286 cases according to the age of women at the census : [2]

Age of Wife	Total Schedules	Defectives Schedules	Per cent
15–19	18,000	388	2·2
20–24	370,300	5,307	1·4
25–29	841,314	9,845	1·2
30–39	1,941,800	25,957	1·3
40–44	812,696	14,304	1·8
45–52	1,008,052	23,244	2·3
53 and over	1,144,443	43,241	3·8
Total .	6,136,605	122,286	2·0

It appears that the eliminations were slightly more important for the age group 15 to 19, which comprised exclusively cases with a short duration of marriage, than for the age groups 20 to 44, and that the eliminations were still larger in the oldest age groups which comprised all cases of late marriages.

[1] *Ibid.*, Part II, p. vii.

[2] The following computation is based on the data given in Tables 1, 5, 9, and 13 ; see *ibid.*, Part I, pp. 1–333, 344, 362–364, 454–462. Those data do not permit a further subdivision of the women of 53 and over.

It seems, therefore, as was to be expected in view of the method applied, that the elimination of erroneous schedules was not as thorough for the wives of 20 to 44 as for both the younger and the older wives.

The Census Report further says: [1]

> Apart from such cases as these there is little evidence in the returns of misstatement of the numbers of living or dead children. This does not imply, of course, that these numbers are accurately returned, but merely that, as might be expected, there is no prejudiced error of statement in favour of one size of family rather than another. This may be inferred from Table 13,[2] which shows that for any group of marriages of similar duration and age of wife at marriage there is a fairly regular increase in the frequency with which different numbers of children are born up to a maximum at a number varying with the circumstances of each group, after which there follows a correspondingly regular decrease.

No doubt the pertaining tables in themselves are not apt to raise any suspicion of inaccuracy. This may be illustrated by the following summary, which shows the ratio of dead children to children born:

TABLE 20.—MORTALITY PER 1,000 CHILDREN BORN ACCORDING TO DURATION OF MARRIAGE, ENGLAND, 1911.[3]

Years Married	Mortality	Years Married	Mortality	Years Married	Mortality	Years Married	Mortality
0	72	14	185	28	230	42	279
1	78	15	189	29	232	43	282
2	90	16	193	30	241	44	288
3	101	17	195	31	235	45	292
4	110	18	198	32	240	46	295
5	120	19	201	33	243	47	300
6	129	20	213	34	247	48	303
7	139	21	212	35	253	49	305
8	146	22	214	36	257	50–54	323
9	151	23	217	37	261	55–59	348
10	161	24	217	38	265	60 and over	382
11	166	25	224	39	267		
12	173	26	225	40	280		
13	177	27	228	41	271	Total	208

[1] *Ibid.*, Part II, p. vii.

[2] See *ibid.*, Part I, pp. 454–464: Families, and Mortality therein, classified by Size of Family, by Age of Wife at Marriage, and by Duration of Marriage, with distinction of the Number of Children Dead in each case.

[3] Computed from *ibid.*, Part I, Table 1, pp. 1–333; Part II, Table 20, p. 8.

With the exception of the "round" years of age, 20, 30, and 40, which fall out of line (because of understatements of the duration of marriage), the proportion of surviving children decreases with every year of increase in the duration of marriage. But does this prove that there was no bias in the statement of children born and children dead? Would not the result be just as smooth if in the case of this investiga tion, as is true of so many similar investigations, many mothers had omitted altogether some or all children who died young. The Census Report states in this respect: [1]

As no statement of the time of birth or age at death of children was required upon the schedules, no direct comparison can be made between the proportions of children returned as dead at different periods of married life and the facts of infant and child mortality during corresponding periods as ascertained from birth and death registration. The subdivision of the first quinquennial duration group of marriages into durations 0–2 and 2–5 years was carried out with the idea that the child mortality of the former might roughly correspond with infant mortality, or at least serve, like this, as a measure of the mortality of infancy, the results from which would be comparable as between different populations. Owing to misstatement of duration at this stage of married life it is doubtful how far even the latter object has been attained; and the actual proportion returned of deaths to children born in the first two years proves to be considerably below the infant mortality rate.

For the year chiefly concerned, 1910, this rate was 102 for legitimate infants, whereas the deaths returned on the census schedules number 77 per 1,000 born. In order to compare these two rates it is necessary to consider the probable age of the children returned on the schedules. The legitimate infant mortality for the first six months of life in 1910 was 74·22, and for the first seven, 79·20, so the census rate corresponds to the mortality of infants of a little over $6\frac{1}{2}$ months of age. The great majority of the infants returned on the schedules must have been under 12 months of age, as out of the 150,250 born to marriages of this duration group (Table 13) 120,770 were born in the second of the two years' duration concerned (Table 1). According to these figures then, the proportion under twelve months of age was over 80 per cent. Notwithstanding the unreliability of the figures it seems certain that the great majority must have been under twelve months, so that an average age corresponding as regards infant mortality to $6\frac{1}{3}$ months appears quite credible. At all events, it may be said

[1] *Ibid.*, Part II, pp. xlviii–xlix.

that such comparison as is possible with the facts derived from registration does not indicate any grave misstatement upon the census schedules. For longer durations the means of comparison become still more scanty, so the test cannot well be carried further. Of course, it is quite conceivable that, notwithstanding completeness of returns made soon after the events recorded, mention of children dying at very early ages might be omitted, many years after the event, upon schedules dealing with marriages of long duration; but no test of this point suggests itself. A degree of inaccuracy in this direction which would have little effect upon the fertility rates might seriously prejudice those of child mortality.

This statement is not quite convincing. The number of children born to marriages with less than one year duration is given as 29,480. Those children were all under one year of age at the census. They had a mortality of 72 per 1,000, a figure which seems quite acceptable. The number of children born to marriages with from one to two years' duration is given as 120,770. Those children were in part under one year, in part over one year, and no one can tell how many of them were under one year. The Census Report apparently assumes that about 29,480 were over one year. In any case, a mortality of 78 per 1,000 for the children born to marriages with from one to two years' duration seems extraordinarily low.

For the marriages of longer duration a checking of the accuracy of the data bearing on child mortality is indeed more difficult. If we take, as an example, the 634,702 marriages with a duration of 30 to 40 years, we find that the total number of children born to such marriages was 3,838,878, of whom 957,616, or 24·9, died before the census.[1]

Assuming the data on duration of marriage to be correct, these 634,702 marriages were all concluded between 3 April, 1871, and 2 April, 1881. In what years were the 3,838,878 children born? Some, who were legitimised by subsequent marriage, will have been born before 1871; some may have been born after 1906. But most of them were born between 1871 and 1900, and at the time of the census were from 10 to 40 years old. Since 24·9 per cent of them had died before

[1] See *ibid.*, Part II, pp. 6, 8.

the census, 75·1 per cent had survived. According to the English Life Tables the percentage of survivors was : [1]

Years of Age	1871–1880	1881–1890	1891–1900
10	72·3	75·0	75·0
20	69·4	72·8	72·6
30	64·4	68·4	68·9
40	57·9	62·2	63·4

Even taking into account that the children comprised in the fertility investigation were practically all legitimate children with both parents still living at the census, and, therefore, probably having a slightly lower mortality than the totality of the children covered by the life tables, the percentage of surviving children derived from the fertility investigation seems very high and arouses some suspicion that the proportion of mothers who may have omitted in their statements children who died young is not negligible.

There exists no means of testing directly whether this suspicion is justified, but it is possible to apply an indirect test of the relative accuracy of the data involved. Let us take as an example the mothers with from five to ten years' duration of marriage who each had borne two children. There were 271,869 such mothers with 543,738 children, of whom 492,836, or 90·64 per cent, survived, and 50,902, or 9·36 per cent, had died. Assuming an equal mortality, there should have been 82·15 per cent or 223,349 cases where no child had died, 16·97 per cent or 46,137 cases where one child had died, and 0·88 per cent or 2,383 cases where both children had died. According to the statements of the mothers, however, there were 224,654 with no child dead, 43,528 with one child dead, and 3,687 with both children dead. The actual mortality would thus have been 9·10, 8·78, and 11·65 per cent. There would then apparently be more cases than would have been expected of mothers with no child dead and with both children dead, and

[1] For 1871–1880 and 1881–1890, computed from *Supplement to the Sixty-Fifth Annual Report of the Registrar-General of Births, Deaths, and Marriages in England and Wales*, 1891–1900, Part I, pp. xlviii, l ; for 1891–1900, see *ibid.*, p. xlvi.

fewer cases of mothers with one child dead. Tables 21 and 22 show the results of a similar computation for other examples.

TABLE 21.—MOTHERS WITH NUMBERS OF CHILDREN BORN AND DEAD, ENGLAND, 1911.

	Mothers with Children Dead								
	0	1	2	3	4	5	6	7	8
Mothers with Two Children Born ; Duration of Marriage 5–10 Years									
a	224,654	43,528	3,687	—	—	—	—	—	—
b	223,349	46,137	2,383	—	—	—	—	—	—
Mothers with Three Children Born ; Duration of Marriage 10–15 Years									
a	104,860	44,014	9,055	930	—	—	—	—	—
b	102,385	48,435	7,638	401	—	—	—	—	—
Mothers with Five Children Born ; Duration of Marriage 20–25 Years									
a	25,756	21,037	11,119	3,855	1,007	150	—	—	—
b	22,009	25,728	12,030	2,813	329	15	—	—	—
Mothers with Seven Children Born ; Duration of Marriage 30–40 Years									
a	13,330	16,885	13,554	7,681	3,630	1,277	330	57	—
b	9,325	19,211	16,962	8,321	2,449	432	42	2	—
Mothers with Eight Children Born ; Duration of Marriage 30–40 Years									
a	10,115	14,220	12,978	8,608	4,795	1,974	707	224	31
b	6,256	15,423	16,634	10,252	3,949	974	150	13	1

a=Census data; computed from *Census*, 1911, vol. xiii, Part I, pp. 427, 456, 457, 459, 461.
b=Expected under the assumption of equal mortality.

TABLE 22.—MOTHERS WITH NO CHILD DEAD AND WITH ALL CHILDREN DEAD, ENGLAND, 1911.

	No Child Dead	All Children Dead	Total				Mortality According to Cases of	
			Mothers	Children Born	Children Dead	Dead per cent	No Child Dead	All Children Dead
Mothers with Two Children Born ; Duration of Marriage 5–10 Years								
a	224,654	3,687	271,869	543,738	50,902	9·36	9·10	11·65
b	223,349	2,383	271,869	543,738	50,902	9·36	9·36	9·36
Mothers with Three Children Born ; Duration of Marriage 10–15 Years								
a	104,860	930	158,859	476,577	64,914	13·62	12·93	18·02
b	103,285	401	158,859	476,577	64,914	13·62	13·62	13·62
Mothers with Five Children Born ; Duration of Marriage 20–25 Years								
a	25,756	150	62,924	314,620	59,618	18·95	16·36	29·89
b	22,009	15	62,924	314,620	59,618	18·95	18·95	18·95
Mothers with Seven Children Born ; Duration of Marriage 30–40 Years								
a	13,330	57	56,744	397,208	90,320	22·74	18·69	37·30
b	9,325	2	56,744	397,208	90,320	22·74	22·74	22·74
Mothers with Eight Children Born ; Duration of Marriage 30–40 Years								
a	10,115	31	53,652	429,216	101,108	23·56	18·82	39·38
b	6,256	0·5	53,652	429,216	101,108	23·56	23·56	23·56

a=Census data; computed from *Census*, 1911, vol. xiii, Part I, pp. 427, 456, 457, 459, 461.
b=Expected under the assumption of equal mortality.

In each example there would be more cases than would have been expected both of mothers with no child dead and mothers with all children dead. There were, for instance, 62,924 mothers who at the time of the census had been married from 20 to 25 years and who each had borne five children. Of these 314,620 children, 59,618 or 18·95 per cent had died before the census. If mortality had been equal, there should have been 22,009 mothers with no child dead, and 15 mothers with all five children dead. But there were reported 25,756 mothers with no child dead, and 150 mothers with all five children dead. The proportion of mothers with no child dead corresponded to a mortality of 16·36 per cent; the proportion of mothers with all five children dead corresponded to a mortality of 29·89 per cent.[1]

If, to choose another instance, we consider the mothers who at the time of the census had been married from 30 to 40 years and had each borne eight children, we find that the numbers of mothers with no child dead and with from four to eight children dead were more numerous than would have been expected, while there were fewer mothers with from one to three children dead than would have been expected.

Is there any plausible explanation for these discrepancies, except erroneous statements of the mothers? Since very little is known about the difference in the chances of survival for children who have lost none or who have lost several brothers and sisters, it is very difficult to answer the question. But since the children of certain families doubtless are particularly subject to death, it is not surprising that the cases of from one to three children having died are comparatively less

[1] The percentage of cases that would have been expected for each group was ascertained by the formula:

$$q^n,\ nq^{n-1}p,\ \frac{n(n-1)}{1.2}q^{n-2}p^2,\ \frac{n(n-1)(n-2)}{1.2.3}q^{n-3}p^3,\ \ldots\ p^n,$$

where n indicates the number of children born, q the percentage of survivors, and p the percentage of children dead.

Example: 62,924 mothers with 314,620 children of whom 255,002 or 81·05 per cent (q) survived, and 59,618 or 18·95 per cent (p) died.
Expected percentage of cases with no child dead $=q^5=34·98$.
Expected number of cases $=34·98$ per cent of $62,924=22,009$.
Reported number of cases $=25,756=40·93$ per cent of 62,924.
q derived from reported number of cases $=\sqrt[5]{0·4093}=83·64$ per cent.

numerous than the cases of from four to eight children having died. But it is hard to understand why cases of seven or eight children having died are comparatively so frequent, and it is still harder to understand why—if the cases of four or more dead children are so numerous—the cases with no dead child should likewise be more numerous than would be expected.

As shown in Table 21, out of the mothers married between 30 and 40 years who each had borne seven children there were reported 13,330 with no child dead and 30,439 with one or two children dead. With equal mortality the expected numbers would have been 9,325 and 36,173 respectively. In a similar manner, out of the mothers married between 30 and 40 years who each had borne eight children there were reported 10,115 with no child dead and 27,198 with one or two children dead, while the expected numbers would have been 6,256 and 32,057 respectively. The considerable surplus of mothers with no child dead makes it appear necessary to examine more closely the statements of mothers with numerous children of whom none is said to have died. Table 23 shows the total number of mothers to whom seven or more children were born, and the number of mothers with no child dead ; Table 24 shows the percentage of mothers with no child dead ; Table 25 shows children's mortality as derived from the reported proportion of mothers with no child dead and children's mortality as it would have been expected according to the total number of reported children dead. It appears that the discrepancy between the proportion of cases with no child dead as derived from the statements of the mothers and the proportion that would have been expected increases with an increasing number of children. To mention only one example : Children's mortality in families with seven children and in families with 16 children was reported as 22 and 42 per cent respectively ; but the proportion of mothers with no child dead indicates a children's mortality in the two groups of 18 and 25 per cent.

The following summary shows the number of cases reported with no child dead and the number of cases that should have been expected according to mortality reported for the entire group :

Children Born	Couples with no Child Dead	
	Reported	Expected
7	71,216	49,959
8	44,636	27,317
9	26,490	14,168
10	15,135	6,432
11	7,131	2,555
12	3,313	797
13	1,360	202
14	496	42
15	175	8
16	54	1

The number of cases in which mothers completely omitted reporting their children who had died and reported only those surviving at the census thus seems to have been very large.

TABLE 23.—ALL COUPLES WITH SEVEN OR MORE CHILDREN BORN AND COUPLES WITH NO CHILD DEAD, ENGLAND, 1911.[1]

Children Born	Duration of Marriage in Years									Total
	5 to 10	10 to 15	15 to 20	20 to 25	25 to 30	30 to 40	40 to 50	50 to 60	60 and over	
All Couples										
7	3,542	45,154	60,706	49,096	39,473	56,744	24,022	4,475	222	283,434
8	870	19,648	46,887	43,297	35,351	53,652	25,138	4,925	232	230,000
9	191	7,349	29,541	35,735	29,475	47,474	23,820	5,110	272	178,967
10	37	2,496	16,030	27,477	24,786	41,086	21,536	4,948	262	138,658
11	7	731	7,168	16,935	17,360	29,581	15,668	3,501	202	91,153
12	—	252	3,365	10,449	12,355	22,104	12,287	2,908	165	63,885
13	—	78	1,262	5,419	7,250	13,434	7,352	1,651	101	36,547
14	—	17	513	2,682	4,048	7,774	4,137	983	50	20,204
15	—	2	195	1,221	2,067	4,095	2,074	477	29	10,160
16	—	—	69	500	1,079	2,143	1,212	315	11	5,329
17	—	—	26	207	451	1,024	544	116	7	2,375
18	—	—	6	101	259	507	274	73	4	1,224
19	—	—	3	51	112	232	130	41	—	569
20	—	—	1	22	57	149	74	20	3	326
21	—	—	—	6	31	77	42	7	—	163
22	—	—	—	3	14	53	28	9	—	107
23	—	—	—	2	6	12	11	2	—	33
24	—	—	—	1	2	10	7	1	—	21
25	—	—	—	—	1	9	2	—	—	12
26	—	—	—	—	1	1	1	—	—	3
28	—	—	—	—	2	1	—	—	—	3
Couples with No Child Dead										
7	576	10,597	17,556	13,697	10,380	13,330	4,471	592	17	71,216
8	105	2,880	10,055	9,815	7,467	10,115	3,616	558	25	44,636
9	19	654	4,251	6,293	5,049	7,046	2,754	417	7	26,490
10	2	131	1,553	3,472	3,195	4,679	1,810	281	12	15,135
11	—	33	446	1,489	1,622	2,430	962	145	4	7,131
12	—	2	137	634	762	1,262	434	79	3	3,313
13	—	—	33	184	324	594	200	25	—	1,360
14	—	1	10	69	131	194	79	12	—	496
15	—	—	1	21	36	84	30	3	—	175
16	—	—	—	3	16	23	10	2	—	54
17	—	—	1	1	3	2	4	1	—	12
18	—	—	—	—	—	6	1	—	—	7
19	—	—	—	1	1	—	—	—	—	2
20 and up	—	—	—	—	—	—	—	—	—	—

[1] Computed from *Census*, 1911, vol. xiii, Tables 12, 13, 19, 20, Part I, pp. 424-464, Part II, pp. 6, 8.

TABLE 24.—PERCENTAGE OF COUPLES WITH SEVEN OR MORE CHILDREN BORN AND NO CHILD DEAD, ENGLAND, 1911.

Children Born	Duration of Marriage in Years						Total
	0–15	15–20	20–25	25–30	30–40	over 40	
7	22·9	28·9	27·9	26·3	23·5	17·7	25·1
8	14·5	21·4	22·7	21·1	18·9	13·9	19·4
9	8·9	14·4	17·6	17·1	14·8	10·9	14·8
10	5·3	9·7	12·6	12·9	11·4	7·9	10·9
11	4·5	6·2	8·8	9·3	8·2	5·7	7·8
12	...	4·1	6·1	6·2	5·7	3·4	5·2
13	—	2·6	3·4	4·5	4·4	2·5	3·7
14	...	1·9	2·6	3·2	2·5	1·8	2·5
15	—	...	1·7	1·7	2·1	1·3	1·7
over 15	—	...	...	1·0	0·7	0·6	0·7

TABLE 25.—MORTALITY DERIVED FROM NUMBER OF COUPLES WITH SEVEN OR MORE CHILDREN BORN AND NO CHILD DEAD, ENGLAND, 1911.

Children Born	Duration of Marriage in Years						Total
	0–15	15–20	20–25	25–30	30–40	over 40	
	Mortality Derived from Census Data						
7	19·0	16·2	16·7	17·4	18·7	21·9	17·9
8	21·4	17·5	16·9	17·7	18·8	21·9	18·5
9	23·5	19·4	17·5	17·8	19·1	21·8	19·1
10	25·6	20·8	18·7	18·5	19·5	22·5	19·9
11	24·6	22·3	19·8	19·4	20·3	22·9	20·7
12	...	23·4	20·8	20·7	21·2	23·5	21·9
13	—	24·4	22·9	21·3	21·3	24·8	22·4
14	...	24·5	23·0	21·7	23·2	25·1	23·3
15	—	...	23·7	23·7	22·8	25·2	23·7
16	—	...	...	23·1	24·7	26·2	24·9
	Expected Mortality						
7	23·1	19·6	20·6	21·2	22·7	26·7	22·0
8	27·1	21·7	21·4	22·2	23·6	27·3	23·4
9	31·1	24·3	22·5	22·9	24·3	27·7	24·6
10	36·1	27·8	24·6	24·7	25·9	29·1	26·4
11	39·3	30·7	26·7	25·8	26·9	30·1	27·7
12	45·0	34·9	30·0	28·8	29·7	32·6	30·6
13	49·3	38·6	33·1	30·6	32·1	35·2	33·0
14	57·1	43·1	36·4	33·7	34·6	37·6	35·7
15	73·3	48·3	39·4	36·9	36·9	39·4	38·1
16	—	49·9	43·6	40·5	41·6	43·9	42·3

2. The total number of married women ascertained at the census was 6,630,284. Of the 6,630,284 schedules 122,286 were " rejected because of evidently defective information," and 493,679 were excluded because the husbands were not enumerated on the same schedule as the wives.

The object of limiting the tabulation to cases where the husband and wife were returned upon the same schedule was primarily in order to take account in the tabulation of the age, occupation and birthplace of both parents, which could only be ascertained in such cases ; but it was also felt that the exclusion of cases where only one parent was present might, on the whole, be advantageous, by securing the exclusion from the table of marriages which had been practically dissolved by the separation of the parties.[1]

The primary reason for limiting the tabulation to cases when the husband and wife were returned upon the same schedule is not convincing. Many tables in the Census Report contain no data whatsoever on the husbands, and those tables at least could easily have included the wives whose husbands were absent at the date of the census. Moreover, the exclusion of cases when only one parent was absent secured the exclusion not only of marriages which had been practically dissolved by the separation of the parties, but also the much more numerous cases when one parent was merely temporarily absent. An omission, however, which was more serious still than the exclusion of the 493,679 wives whose husbands were absent at the date of the census was the exclusion of the 1,364,804 widows. When Dr. Stevenson, in a paper read before the Royal Statistical Society, on 21 June, 1910, had explained the limited scope of the investigation several members pointed, in vain, to the grave consequences of this limitation :

Mr. R. H. Hooker observed that it was proposed to obtain particulars of children only from husbands and wives enumerated in the same schedule. This would militate very seriously against a comparison, suggested later on, with the much earlier periods before the fall in the birth-rate commenced, and he would urge that widows and widowers should also be asked to state the number of their children. Otherwise, only an exceedingly small sample would be obtained regarding " women married long before the fall in the

[1] *Census*, 1911, vol. xiii, Part II, p. vii.

birth-rate commenced " ; in fact, details for " women whose fertile period was completed " before that time would only be forthcoming from those parents who had practically celebrated their golden wedding. If all persons who had been married were required to answer these questions, the particulars of fertility according to age of both husband and wife could easily be ascertained by tabulating separately the replies from those enumerated on the same schedule ; while the inclusion of all would give an enormously larger sample for obtaining particulars according to age of a single parent only.[1]

Mr. Yule . . . supported Mr. Hooker concerning the tabulation of the fertility of widows.[2]

Dr. Stevenson, in reply, . . . quite appreciated the cogency of the reasoning urged by Mr. Hooker for his suggestion that the fertility questions should be put with regard to widows and widowers as well as married persons in respect of the table, for linking up the fertility of the past with that of the present time ; but he was afraid there were practical reasons of convenience, both from the point of view of the householder and of the compilers of the table which would tell against that, and the Census Act would probably contain no authorization of the questions in respect to the widowed.[3]

Table 26 shows the ages of the married women and widows

TABLE 26.—WIVES AND WIDOWS, ENGLAND, 1911.[4]

Years of Age	Husband Present	Husband Absent	Husband Dead	Total
15–19	18,000	2,111	89	20,200
20–24	370,300	33,761	2,487	406,548
25–29	841,314	65,121	12,197	918,632
30–34	994,888	72,079	28,671	1,095,638
35–39	946,912	69,478	50,910	1,067,300
40–44	812,696	60,761	76,028	949,485
45–49	673,393	54,902	106,776	835,071
50–54	525,296	46,387	137,801	709,484
55–59	383,272	34,962	161,504	579,738
60–64	265,630	24,485	183,229	473,344
65–69	170,991	16,105	200,864	387,960
70–74	88,824	8,387	180,653	277,864
75–79	34,053	3,506	123,065	160,624
80–84	9,221	1,164	66,722	77,107
85–89	1,624	361	26,262	28,247
90–94	177	91	6,483	6,751
95–99	13	16	991	1,020
100 and over	1	2	72	75
Total .	6,136,605	493,679	1,364,804	7,995,088

[1] *Journal of the Royal Statistical Society*, vol. lxxiii, 1910, p. 709.
[2] *Ibid.*, p. 710. [3] *Ibid.*, pp. 712–713.
[4] See *Census*, 1911, vol. xiii, Part I, pp. 368–369.

at the census, giving (1) the wives whose husbands were present, (2) the wives whose husbands were absent, and (3) widows.

As was to be expected, the exclusion of widows led to the exclusion of the majority of older women :

Years of Age	Schedules Analysed	Schedules Excluded			Total[1]
		Defective Information	Husband Absent	Husband Dead	
15–52	4,913,117	79,045	387,531	357,140	5,736,833
53 and over	1,101,202	43,241	106,148	1,007,664	2,258,255

The investigation of fertility, as a whole, included 6,014,319, or 75 per cent of all women who were married or had been married. The total number of children born to those women was 21,228,248. The oldest of these children were born in the 1840's, the youngest were born in the first three months of 1911. In order to convey a picture of the proportion of the children included, it may be mentioned that the total number of legitimate children born in England and Wales in 1845–1910 aggregated 50,586,880. One reason why only a minority of the legitimate children born in that period have been covered by the investigation has already been stated: one-fourth of the schedules was excluded either because of evidently defective information or because of the absence or death of the father. Another reason was the exclusion of children born to a former marriage of the mother. But the main reason was that many children had lost their mothers before the 1911 census.

3. The fact that 21,228,248 children were born to 6,014,319 wives, *i.e.* 3·53 children on an average, of course, is meaningless since part of these women had been married only a short time and very many were still of child-bearing age. The investigation of fertility, therefore, has rightly been confined on the whole to the 2,002,765 wives over 45 years of age who were under 45 when marrying. The number of children born to

[1] Women who were married, or had been married, excluding divorced women, who were not identified at the census of 1911.

those women aggregated 10,160,291, or 5·07 per wife. But while such wives had this in common, that they had practically all passed the child-bearing age, their marriage had occurred any time between the 1840's and 1911, and the same is true of the births of their children. Moreover, " the record closes at an earlier date for the marriages entered into early in life, as at least thirty years duration is requisite in the case of the woman married at 15 to qualify for admission to the table, while at later ages the necessary duration is correspondingly less." [1] It therefore seems advisable to show for the women over 45 years of age fertility according to age at marriage and duration of marriage. This has been done in Table 27.

TABLE 27.—WIVES OF 45 YEARS AND OVER AND THEIR CHILDREN, ENGLAND, 1911.

Duration of Marriage Years	Wife's Age at Marriage, in Years					
	15–19	20–24	25–29	30–34	35–39	40–44
			Wives [2]			
50 and over	12,123	30,451	7,848	1,130	115	
45–49	19,099	50,937	16,511	3,038	504	63
40–44	33,491	88,425	34,042	8,509	1,807	357
35–39	54,864	137,656	53,078	15,470	4,185	984
30–34	68,687	186,978	77,747	23,336	7,901	2,730
25–29	49,514	246,770	106,169	31,760	10,872	4,414
20–24	—	109,520	154,358	46,785	17,391	7,543
15–19	—	—	58,126	65,035	23,824	10,906
10–14	—	—	—	24,817	35,131	15,586
5– 9	—	—	—	—	12,987	20,524
0– 4	—	—	—	—	—	8,667
			Children [3]			
50 and over	104,508	223,227	44,444	4,685	247	
45–49	163,592	365,471	88,588	11,852	1,217	54
40–44	280,230	616,823	179,559	31,220	4,095	355
35–39	447,120	909,577	262,201	54,588	8,402	656
30–34	538,262	1,166,601	356,451	77,408	15,427	2,075
25–29	366,293	1,438,079	448,786	95,810	18,525	2,473
20–24	—	552,879	597,909	128,332	27,181	3,713
15–19	—	—	193,905	161,159	32,307	4,469
10–14	—	—	—	52,518	45,673	6,506
5– 9	—	—	—	—	13,582	9,295
0– 4	—	—	—	—	—	1,962
Total .	1,900,005	5,272,657	2,171,843	617,572	198,214	
			Children Born per 100 *Wives*			
50 and over	862	733	566	415	215	
45–49	857	717	537	390	241	84
40–44	837	698	527	367	227	99
35–39	815	661	494	353	201	67
30–34	784	624	458	332	195	76
25–29	740	583	423	302	170	56
20–24	—	505	387	274	156	49
15–19	—	—	334	248	136	41
10–14	—	—	—	212	130	42
5– 9	—	—	—	—	105	45
0– 4	—	—	—	—	—	23

[1] *Census*, 1911, vol. xiii, Part II, p. xxxvii.
[2] See *ibid.*, pp. 4–5.
[3] See *ibid.*, Part I, pp. 454–463 ; Part II, p. 7.

It appears that for each age group at marriage under 40 the average number of children decreases with every quinquennial period by which the date of marriage approaches the census. The marriages concluded before 1861 appear to have been more fertile than those contracted in 1861–1866, those of 1866–1871 more fertile than those of 1871–1876, etc. The Census Report points to the fact that in 1876 " the birth rate reached a maximum after a period of slight apparent increase, which may or may not have been real," and that the " agreement of the census and registration data affords interesting evidence of the substantial accuracy of both." [1] In order to check this statement we show in Table 28 the trend of the number of legitimate births per 1,000 married women aged 15–45 years.

TABLE 28.—LEGITIMATE FERTILITY RATE, ENGLAND, 1851–1910.[2]

Period	Years Passed at Census	Legitimate Fertility Rate
1851–1860	50–60	281·0
1861–1865	45–50	285·1
1866–1870	40–45	289·4
1871–1875	35–40	294·6
1876–1880	30–35	296·3
1881–1885	25–30	282·4
1886–1890	20–25	267·1
1891–1895	15–20	258·3
1896–1900	10–15	242·9
1901–1905	5–10	230·5
1906–1910	0– 5	212·9

Even assuming that the increase of the legitimate fertility rate in the seventies as compared with 1851–1870 was not real, but due to more complete registration, an approximately constant fertility rate from 1851–1880 would indicate an approximately equal fertility for all marriages with a duration of over 40 years in 1911. The fact that the couples who in 1911 were married over 50 years had been more fertile than those who were married 40 to 45 years, and still more fertile than those who were married 45 to 50 years seems then to indicate

[1] *Ibid.*, Part II, pp. xxxvii, xxxix.

[2] See *The Registrar-General's Statistical Review of England and Wales for the Year* 1932, Tables, Part II, Civil, p. 6.

that the couples who survived their honeymoon by over 50 years did not show the average fertility of the couples married over 50 years ago, but were more prolific than those who, measured by longevity, were of lesser vitality.

While the apparent decrease of fertility of the couples married in 1861–1871 as compared with those married before 1861 cannot be reconciled with a constant legitimate fertility rate, a decrease of fertility of the couples married after 1871 might have been expected from what was known about the trend of the fertility rate. But this decrease again was much larger than would have been expected. The fertility of the couples married from 20 to 24 years with children mainly born between 1887 and 1905, appears to have been by about 30 per cent lower than the fertility of the couples married from 45 to 49 years whose children were mainly born in the sixties and seventies, while the trend of the legitimate fertility rate would indicate a decrease of about 15 per cent. This result is the more remarkable as the omissions of children who had died young were particularly numerous on the part of couples with a long duration of marriage.

It thus seems that the longer the duration of marriage the more do couples surviving the census represent a selected group with an abnormally high fertility. The English fertility census of 1911, therefore, makes the decline of fertility appear considerably greater than it actually was.

2. Ratio of Births, Derived from Number of Children, to Women at Child-bearing Age

A more indirect method of measuring fertility through the exclusive use of census statistics consists in relating the number of children ascertained at the census to the total population or to the number of adults at reproductive age or of females only at child-bearing age. Sadler (1830), who apparently was the first to use this method, applied it both to Ireland and to the United States.

The census of Ireland, for it is to that which we shall first advert, presents us with the population of the Island, and of each county separately, divided into thirteen columns, into which the whole number is classed according to the ages specified. Now it is clear that, other circumstances being the same, the variations in the proportion of children under a certain age, (say ten years, in order to assimilate the proof as far as may be with that which will be founded on the American censuses,) compared with the prolific adults, those, for instance, from the ages of fifteen to forty inclusive, will indicate the prolificness of marriages in the several counties throughout the island.[1]

Sadler related the children under 10 enumerated at the Irish Census of 1821 to the inhabitants between 15 and 40.[2] Since for the United States the population in 1800, 1810, and 1820 was " not only classed in ages peculiarly adapted to such an inquiry as that pursued respecting Ireland, but into sexes also, affording an additional precision to the computation," [3] he related the children under 10 to the females from 16 to 45.[4] For 1790, when the data were not available in such detail, he related the free white males under 16 to all free white females.[5]

The main defects of this method of Sadler are :

1. Children born in the course of a decade are related to adults living at the end of the decade. This incongruency is not important whenever the number of adults is fairly constant. There was no harm, for instance, in relating the 74,750 children under 10, enumerated in Maryland in 1810, to the 46,783 females from 16 to 45 enumerated in 1810, since those females in 1800 numbered 45,333. But it was utterly misleading to relate the 90,815 children under 10, enumerated in Ohio in 1810 to the 39,426 females from 16 to 45 enumerated in 1810, since those females, in 1800, numbered 7,203 only.

2. The children under 10 found at a census are the survivors only of the children born in the preceding decade, and therefore do not offer an adequate gauge of fertility.

These defects can be attenuated (1) by considering only the

[1] Sadler, *The Law of Population*, vol. ii, pp. 430–431.
[2] See *ibid.*, pp. 433, 471.
[3] *Ibid.*, p. 435.
[4] See *ibid.*, pp. 440–441, 443–446, 497–500.
[5] See *ibid.*, p. 437.

children under five or under one (instead of under 10), (2) by deriving the number of births from the number of children reported as surviving.

(1) At the United States censuses of 1850 and 1870–1900, the number of children under one year of age has been related to the total census population (or, as in 1870, to the women of child-bearing age). This, theoretically, was an improvement over Sadler's method. But the practical advantage is dubious, since children under one are more or less frequently omitted or reported as one year old at the censuses. Willcox, therefore, in analysing the proportion of children in 1900, chose as a basis the children under five : [1]

> The enumeration of children under 5 years of age is admitted by everyone to be far more accurate and complete than the enumeration of children under 1 year of age. The proportion of children is thus an approximately accurate and a significant clue to the amount of new blood that is being brought into the country by nature's processes of reproduction and growth.

Willcox related the number of children under five years to the number of females 15 to 49 years of age. Practically the same method was followed by Warren S. Thompson in analysing the results of the census of 1920.[2] He related the children under five to all females 20 to 44 years of age, and specifically to the females of that age who were or had been married. It is evident, however, that by relating the children born in a quinquennial (and not a decennial) period to adults living at the end of that period the defect of the method, as used by Sadler, is reduced but not eliminated.

The only progress achieved in the use of Sadler's method must be credited to William S. Rossiter (1922), who in order to measure "Fertility of Native Whites" in the United States, 1910–1920, proposed to relate the children under 10 to the mean population of the preceding decade : [3]

[1] *Supplementary Analysis and Derivative Tables, Twelfth Census*, p. 408.
[2] See *Ratio of Children to Women*, 1920, Census Monograph XI, Washington, 1931.
[3] *Increase of Population in the United States*, 1910–1920, Census Monographs I, p. 205.

By dividing the number of native white children under 10 years of age, excluding those of foreign parentage and one-half those of mixed parentage, enumerated in a given division or state, by the average number of native white persons in the same division or state during the decade (that is, a simple average of the numbers enumerated at the beginning and end of the decade), roughly comparable rates can be established for the native white element for the decade 1910–1920.

(2) The first attempt to derive the number of births from the children reported as surviving was made in connection with the United States census of 1850, when the children reported as dead under one in the year preceding the census were used for supplementing the number of survivors. The same attempt was repeated at subsequent censuses until and including 1900. But the reported death figures were perhaps still more deficient than the data on the children surviving. In order to appraise the deficiency of the results thus obtained, and in order at the same time to find independently the number of births, various attempts were made to derive the number of births from the total population increase between two censuses or from the number of older children at a subsequent census, taking account of mortality and immigration. Another attempt in the same direction has recently been made by Thompson and Whelpton, who adjusted the number of living children under five and by assuming a certain mortality for these children computed the number of births in the United States for the entire nineteenth century,[1] and related it to the population.

This indirect method is the best method of roughly measuring fertility in countries which take censuses, but have no adequate birth registration.

[1] See Thompson, Warren S., and Whelpton, P. K., *Population Trends in the United States*, p. 263, New York and London, 1933.

CHAPTER IV

MEASUREMENT OF FERTILITY BY USE OF VITAL AND CENSUS STATISTICS

1. Crude Birth Rate

The most common method of measuring fertility by the use of vital and census statistics consists in relating the number of births to the total population. This method of computing a *birth rate* had been used before censuses were taken by relating the births to the estimated population.

John Graunt (1662) came very near computing a birth rate, but he never actually did so, since he confined himself to computing a death rate and to computing the proportion of births to deaths. In discussing births and deaths in "a certain Parish in Hampshire," with a population of "about 27 or 2800 Souls," 70 yearly baptisms and 58 yearly deaths, he thus concludes "that little more then one of 50 dies in the Country" and that "there have been five Christnings for four Burials." [1] It was Sir William Petty (1682) who, following Graunt's line of thought, was the first to relate births directly to the population. He assumed a community with 600 inhabitants ("Suppose there be 600 people") and stated : [2]

> There are also other good *Observations*, That even in the Countrey, one in about 30, or 32 *per Annum* hath dyed, and that there have been five *Births* for four *Burials*. Now, according to this Doctrine, 20 will dye *per Annum* out of the above 600, and 25 will be Born . . .

While Petty contented himself with stating that out of 600 people 25 will be born, Gregory King (1696)—by a big detour, it is true—arrived at a birth rate expressed in the now usual way of computing births per 1,000 inhabitants. He con-

[1] Graunt, *Natural and Political Observations*, 1st ed., pp. 65, 69.
[2] Petty, *Another Essay in Political Arithmetick*, pp. 12–13, London 1683.

cluded from the "assessments on marriages, births, and burials, and the collector's returns thereupon, and [from] the parish registers" that there occurred in London one marriage in 106 persons "producing 4 Child^{n} each," and therefore one birth in $26\frac{1}{2}$ persons. "Whence we may observe, that in 1000 co-existing persons, there are . . . 9·4 marriages in London, producing 37·6 children." Through the same method he found a birth rate of 35·2 for the "Cities and Market Towns," and 34·3 for "the Villages and Hamlets." [1]

The population to which the births of a given period are related is either the population at the beginning of the period or the population at the end of the period, or the population in the middle of the period, or the mean population of the period. The best method of computing the birth rate is to relate the births to the mean population of the period. The mean population of a year is computed as a rule by taking the average of the population at the beginning and at the end of the year. The mean population of a longer period is best computed by taking the average of the mean yearly populations.

What is the range of the birth rate? Many attempts have been made to estimate the upper limit. The first to try it was Sir William Petty in 1682. He assumed that of each 1,000 inhabitants 300 are females between 15 and 45 years, and that every such female can bear a child once in two years. This would yield 150 births per 1,000 inhabitants. But in view of "sickness, young abortions, and natural barrenness," he reduces the possible rate to 125. Another estimate which often recurs in the German literature of the last sixty years runs as follows: Females, as a rule, are fecund for 22 years; women of that age period constitute 165 per 1,000 of the total population; of each 165 females 15 are barren. If the 150 fecund females bear a child each year, the birth rate would be 150.

Both these estimates arrive at exaggerated birth rates. They were made under the assumption that the proportion

[1] King, Gregory, *Natural and Political Observations and Conclusions upon the State and Condition of England*, 1696, p. 44, London, 1810.

of women at child-bearing age would not be affected by an increase of fertility. But unless mortality changes, the proportion of women at child-bearing age is bound to decrease if fertility increases, because with increasing fertility the proportion of children increases. Let us assume that in England mortality remains constant, but that from 1935 on every female between 17 and 47 years would have a child every eighteen months. The birth rate in 1935 would jump to 149. But the proportion of children under 15 years, which is now 23 per cent of the total population, would increase considerably and would ultimately be 70 per cent, while the proportion of females between 15 and 50, which is now 28 per cent, would decrease and would ultimately be 14 per cent only. At the same time the birth rate would drop from 149 to 83, and after that would remain on that level as long as fertility and mortality remained constant. If, then, we assume—a quite arbitrary assumption, of course—that the upper limit of fertility in England would be reached, if every female between 17 and 47 years had a child every eighteen months, the upper limit of the birth rate with present mortality would not exceed 83 in the long run.

Actual birth rates, of course, are lower than the upper limit because fecundity is nowhere realized to the full. Probably there never was a country with a birth rate exceeding 65. On the other hand, it is very rare, so far, for the birth rate to fall below 10, as it did in France in 1916. Actual birth rates, as a rule, lie between 13 and 55. Table 29 gives a survey of the birth rates for various countries.[1]

It is generally believed that the birth rate in Western and Northern Europe was fairly constant until about 1876, and then began to decline. This view, however, is not quite right. The birth rate prior to 1815 showed frequent ups and downs ; it apparently decreased in the 25 years following the Napoleonic wars ; and after that it was fairly constant up to about 1886. If we combine all countries of Western and Northern Europe

[1] For the basic data, *i.e.* the mean population and the number of births, see Tables I and II in the Appendix. For earlier years, see *The Balance of Births and Deaths*, vol. i, pp. 6, 94–95, 98–101 ; vol. ii, pp. 134, 136–137.

for 1841–1880, we find that the average quinquennial birth rate oscillated between 30·7 in 1851–1855, and 32·7 in 1876–1880; it amounted to 31·3 in 1881–1885. There was, to be sure, a decrease in the late seventies and early eighties, but this decrease was not greater than that which had occurred on numerous previous occasions. The decisive factor was that the decrease of the birth rate did not stop in the eighties, but proved to be continuous. The average birth rate in 1911–1914 amounted only to 24.

The World War did not essentially change the trend of the birth rate. During the war the birth rate was very low, being only 17 in 1915–1919. Immediately after the war the occurrence of many marriages which had been postponed caused the birth rate to rise temporarily. But even in 1920–21 it was not quite 24, and by 1932–33 it had fallen to 16. It is, then, only half of what it was from 1841 to 1885. Although the population of Western and Northern Europe has increased in the course of the last 90 years by almost 80 per cent, the absolute number of births is considerably lower than it was 90 years ago.

But the drop of the birth rate was by no means confined to Western and Northern Europe. It occurred in North America, in Oceania, and finally also in Southern and Eastern Europe. With the exception of Russia, where natality, while being lower than before the World War, is still at least as high as it was in Western and Northern Europe 50 years ago, practically all countries inhabited by whites have by now passed the stage through which Western and Northern Europe went in the 1880's and 1890's. It is, moreover, noteworthy that in countries where the decrease of the birth rate started particularly late, the decrease was particularly rapid. While it took France about 75 years to experience a drop in her birth rate from 30 to 20, while this process lasted about 40 years in Sweden and Switzerland, and about 30 years in England and Denmark, in the last eight or ten years the birth rate has fallen in Bulgaria from 40 to 29, in Poland from 35 to 26, in Czechoslovakia from 27 to 19. The birth rate of Bulgaria, which was still in 1924 much higher than it ever

TABLE 29.—YEARLY

1. *Western and Northern*

Years	Belgium	Denmark	England and Wales	Scotland	Northern Ireland	Irish Free State	Ireland (Total)
1841–45	32·3	30·1	32·3	—	—	—	—
1846–50	28·6	30·7	32·8	—	—	—	—
1851–55	28·9	31·9	33·9	31·3 [1]	—	—	—
1856–60	31·1	32·9	34·4	34·5	—	—	—
1861–65	31·3	30·9	35·1	35·1	—	—	25·0 [2]
1866–70	32·1	30·6	35·3	34·9	—	—	26·8
1871–75	32·4	30·8	35·5	35·0	—	—	27·2
1876–80	32·0	32·0	35·3	34·7	—	—	25·8
1881–85	30·9	32·4	33·5	33·3	—	—	23·9
1886–90	29·4	31·4	31·4	31·4	—	—	22·8
1891–95	29·1	30·4	30·5	30·5	—	—	23·0
1896–00	29·0	30·0	29·3	30·0	—	—	23·3
1901–05	27·9	29·0	28·2	29·2	—	—	23·1
1906–10	24·8	28·2	26·3	27·6	—	—	23·3
1911–14	22·2	26·1	24·1	25·8	24·2	22·6	23·0
1915–19	13·8	23·8	19·4	21·9	21·9	20·6	21·0
1920	22·2	25·3	25·5	28·1	25·9	21·6	22·8
1921	22·0	24·0	22·4	25·2	23·6	19·7	20·8
1922	20·5	22·2	20·4	23·5	23·3	19·5	20·6
1923	20·6	22·3	19·7	22·9	23·9	20·5	21·5
1924	20·1	21·8	18·8	22·0	22·7	21·1	21·6
1925	19·9	21·0	18·3	21·4	22·0	20·8	21·2
1926	19·2	20·5	17·8	21·1	22·5	20·6	21·2
1927	18·4	19·6	16·6	19·9	21·3	20·3	20·6
1928	18·5	19·6	16·7	20·0	20·8	20·1	20·3
1929	18·3	18·6	16·3	19·2	20·4	19·8	20·0
1930	18·8	18·7	16·3	19·6	20·8	19·8	20·1
1931	18·3	18·0	15·8	19·0	20·5	19·3	19·7
1932	17·7	18·0	15·3	18·6	19·9	18·9	19·2
1933	16·5	17·3	14·4	17·6	19·4	19·2	19·2

See footnote to Tables I and II, Appendix.

[1] 1855 only.

2. *Other*

Years	Austria		Bulgaria	Czecho-slovakia	Danzig	Estonia	Finland	Hungary		Italy
	(1)	(2)						(1)	(2)	
1871–75	39·3	34·5	—	—	—	—	37·0	43·1	—	36·8 [1]
1876–80	38·7	34·0	—	—	—	—	36·9	44·4	—	36·9
1881–85	38·3	32·9	—	—	—	—	35·5	44·4	—	38·0
1886–90	37·8	32·0	36·3 [4]	—	—	—	34·5	43·5	—	37·5
1891–95	37·4	31·7	37·5	—	—	—	31·8	41 7	—	36·0
1896–00	37·3	31·5	41·0	—	—	—	32·6	39·4	—	34·0
1901–05	35·7	30·4	40·7	35·1	—	—	31·3	37·4	—	32·6
1906–10	33·7	27·8	42·1	32·9	—	—	30·9	36·7	—	32·7
1911–14	30·8 [5]	24·7 [5]	38·2	29·6	—	—	28·1	35·1	34·3	31·7
1915–19	—	18·5 [7]	26·3	22·6 [7]	—	—	23·3	18·1 [8]	20·2	22·7
1920	22·7	22·7	39·9	26·8	32·2	—	25·3	31·4	31·4	—
1921	23·2	23·2	40·2	29·2	31·3	—	24·3	31·8	31·8	30·8
1922	23·1	23·1	40·5	28·2	27·9	20·2	23·4	30·8	30·8	30·8
1923	22·4	22·4	37·7	27·3	26·4	20·1	23·7	29·2	29·2	30·0
1924	21·6	21·6	39·8	25·8	26·7	19·2	22·4	26·9	26·9	29·0
1925	20·5	20·5	36·9	25·1	25·6	18·3	22·3	28·4	28·4	28·4
1926	19·1	19·1	37·4	24·6	24·1	17·9	21·7	27·4	27·4	27·7
1927	17·8	17·8	33·2	23·3	23·2	17·7	21·1	25·9	25·9	27·5
1928	17·5	17·5	33·1	23·3	23·1	18·0	21·5	26·4	26·4	26·7
1929	16·7	16·7	30·6	22·4	22·3	17·1	20·9	25·1	25·1	25·6
1930	16·8	16·8	31·3	22·7	22·1	17·4	20·6	25·4	25·4	26·7
1931	15·9	15·9	29·4	21·5	20·6	17·4	19·5	23·7	23·7	24·9
1932	15·2	15·2	31·4	21·0	19·9	17·6	18·7	23·5	23·5	23·8
1933	14·3	14·3	29·0	19·2	19·0	16·2	17·4	22·0	22·0	23·7

See footnote to

[1] 1872–1875 only. [2] 1873–1875 only. [3] 1878–1880 only. [4] 1888–1890 only.

IRTH RATES.

urope, 1841–1933.

France		Germany		Holland	Norway	Sweden	Switzer-land	Total	Years
(1)	(2)	(1)	(2)						
28·1	28·3	36·8	36·3	34·4	30·4	31·3	—	31·8	1841–45
26·7	26·9	35·8	35·3	31·7	30·9	30·9	—	30·8	1846–50
26·1	26·2	34·9	34·3	33·3	32·5	31·8	—	30·7	1851–55
26·6	26·7	36·3	35·7	33·0	33·3	33·7	—	31·6	1856–60
26·7	26·7	37·0	36·5	35·3	31·9	33·2	—	32·0	1861–65
26·1	26·1	37·8	37·2	35·2	29·9	29·7	29·8 [3]	32·0	1866–70
25·5	25·9	38·9	38·7	36·1	30·3	30·7	30·2	32·6	1871–75
25·3	25·7	39·2	39·0	36·4	31·6	30·3	31·3	32·7	1876–80
24·7	25·0	37·0	36·8	34·8	31·0	29·4	28·7	31·3	1881–85
23·0	23·3	36·5	36·4	33·6	30·5	28·8	27·5	30·1	1886–90
22·3	22·6	36·3	36·1	32·9	30·1	27·4	27·7	29·7	1891–95
21·9	22·3	36·0	35·7	32·2	30·0	26·9	28·4	29·3	1896–00
21·2	21·6	34·3	34·0	31·5	28·5	26·1	27·8	28·4	1901–05
19·9	20·2	31·6	31·3	29·6	26·4	25·4	26·0	26·5	1906–10
18·6	18·8	27·8	27·5	28·1	25·3	23·5	23·5	24·1	1911–14
11·3	11·4	16·7	16·4	25·8	24·0	20·8	18·9	16·9	1915–19
21·4	21·4	25·9	25·8	28·6	26·1	23·6	20·9	24·5	1920
20·7	20·7	25·3	25·2	27·7	24·2	21·5	20·8	23·2	1921
19·3	19·3	23·0	23·0	26·1	23·3	19·6	19·7	21·4	1922
19·1	19·1	21·1	21·2	26·2	22·7	18·9	19·5	20·6	1923
18·7	18·7	20·5	20·6	25·1	21·3	18·1	18·9	19·9	1924
19·0	19·0	20·7	20·8	24·2	19·7	17·6	18·6	19·8	1925
18·8	18·8	19·5	19·6	23·8	19·6	16·8	18·3	19·2	1926
18·2	18·2	18·4	18·4	23·1	18·1	16·1	17·6	18·2	1927
18·3	18·3	18·6	18·6	23·3	17·9	16·1	17·4	18·3	1928
17·7	17·7	17·9	18·0	22·8	17·3	15·2	17·2	17·7	1929
18·0	18·0	17·5	17·6	23·1	17·0	15·4	17·2	17·7	1930
17·5	17·5	16·0	16·0	22·2	16·3	14·8	16·7	16·9	1931
17·3	17·3	15·1	15·1	22·0	16·0	14·5	16·7	16·3	1932
16·3	16·3	14·7	14·7	20·8	14·9	13·7	16·4	15·6	1933

[2] 1864–1865 only.

[3] 1870 only.

ountries, 1871–1933.

Latvia	Lithuania	Poland	Portugal	Rumania	Russia (Europe)	Spain	Yugo-slavia	Australia	New Zealand	Years
—	—	—	—	35·3 [2]	51·2	—	42·6	37·0	40·0	1871–75
—	—	—	—	36·2	49·5	35·8 [3]	38·9	35·5	41·3	1876–80
—	—	—	—	42·2	50·7	36·4	46·8	35·2	36·4	1881–85
—	—	—	—	41·2	50·2	36·0	44·1	35·2	31·2	1886–90
—	—	—	—	41·2	48·9	35·3	43·6	32·4	27·7	1891–95
—	—	—	—	40·5	49·5	34·3	40·4	27·7	25·8	1896–00
—	—	—	—	39·6	47·7	35·1	39·0	26·4	26·6	1901–05
—	—	—	—	40·6	45·8	33·2	39·3	26·7	27·1	1906–10
—	—	—	32·7 [6]	42·9	44·0	30·8	—	28·0	26·1	1911–14
—	17·0	30·5 [7]	30·2	40·8 [9]	—	29·4	—	25·7	24·3	1915–19
—	22·7	32·2	33·7	34·8	—	29·3	35·5	25·5	25·1	1920
—	24·6	32·8	32·5	39·6	—	30·3	36·7	25·0	23·3	1921
22·7	27·2	35·3	33·3	38·6	—	30·4	34·3	24·7	23·2	1922
22·9	28·2	35·8	33·6	37·7	38·8	30·5	34·8	23·7	21·9	1923
22·4	29·2	34·7	33·3	38·0	42·9	29·9	35·1	23·2	21·6	1924
22·3	28·8	35·3	33·1	36·4	44·2	29·2	34·1	22·9	21·2	1925
22·0	28·4	33·1	33·7	36·0	43·7	29·9	35·2	22·0	21·0	1926
22·2	29·1	31·6	31·0	35·1	43·2	28·4	34·1	21·6	20·3	1927
20·7	28·7	32·3	32·5	35·8	42·0	29·6	32·6	21·3	19·6	1928
18·8	27·1	32·0	30·6	34·0	37·5	28·8	33·3	20·2	19·0	1929
19·8	27·3	32·5	30·6	34·9	—	28·9	35·5	19·9	18·8	1930
19·3	26·6	30·2	30·4	33·3	—	27·9	33·6	18·2	18·4	1931
19·4	27·2	28·8	30·6	35·9	—	28·1	32·8	16·9	17·1	1932
17·9	25·5	26·5	29·7	32·0	—	27·7	—	16·8	16·6	1933

ables I and II, Appendix.

[5] 1911–1913 only. [6] 1912–1914 only. [7] 1919 only. [8] 1915–1918 only. [9] 1915 only.

was in England, was lower in 1933 than it ever was in England before 1900, and the 1933 birth rate of Italy was lower than the birth rate of England or Germany in any pre-war year.

2. General Fertility Rate

The birth rate shows the proportion by which a population increases through the birth of children, but it is not an adequate measure of fertility, since it is calculated without regard to the sex and age composition of the population. The factor of sex composition is eliminated by relating births to the total female population. This has been done, for instance, in the *Eighth Annual Report of the Registrar-General of Births, Deaths, and Marriages in England* (1845), where the average number of births in 1839–1845 is related to the female census population of 1841. That ratio, however, has been computed very seldom, since it seemed preferable to take at the same time account of the age composition of the female population.

The crudest method of taking account of the age composition of the female population in measuring fertility consists in excluding the females under and above child-bearing age. This method apparently has been visualized by John Graunt (1662), who, in discussing the number of births in London, " considered, that the number of Child-bearing women might be about double to the Births : forasmuch as such women, one with another, have scarce more then one Childe in two years." [1] But the ratio he thus implicitly established—500 births per 1,000 women of child-bearing age—was a mere assumption, since he did not know the number of women of child-bearing age. The first who computed the ratio of births to the women of child-bearing age was Nicolas Struyck (1753).[2]

[1] Graunt, p. 60.

[2] See Struyck, *Suite de la description des comètes, et découvertes plus détaillées concernant l'état du genre humain*, etc., Amsterdam, 1753, see *Œuvres*, pp. 268–289, Amsterdam, 1912. Having ascertained that in a number of Dutch villages there had been 7,236 married couples and 1,644 yearly births, he concluded : " Cinq enfants naissent donc annuellement de 22 couples mariés, ou, si l'on veut, 15 enfants de 66 couples. A Warder il y avait 66 femmes mariées, parmi lesquelles 48 entre 20 et 45 ans, c.à.d. capables quant à l'âge d'avoir des enfants. C'est d'elles que

The computation of the *general fertility rate*, i.e. the ratio of births to women of child-bearing age, presupposes a knowledge concerning which years of life the child-bearing age comprises. Recent statistics report on the one hand births to girls as young as 11 years of age,[1] and on the other hand births to women as old as 62 or 63 years.[2] But since the females between 11 and 63 everywhere comprise the vast majority of the total female population, a general fertility rate computed by relating the births to the females between 11 and 63 would take very slightly account of the differences in the age composition of the females in various countries and at various periods. Moreover, deliveries of very young and very old females are exceptional cases of no statistical importance.

There is no particular difficulty in choosing the lower limit for statistical purposes. Mothers under 15 are so rare that, as a rule, they are not reported separately, but are included in a higher age group (for instance, in the group under 20). We have assembled in Table 30 the number of mothers under 15 for some countries and periods where they have been reported separately.

It appears that among the coloured in the United States 5 per 1,000 of all children were borne by women under 15, while in each other case the proportion of such children was less than $\frac{1}{2}$ per 1,000. In most countries the number of births to women even of 15 and 16 years of age is exceedingly small, but since conditions vary a good deal in

proviennent les 15 enfants. Il s'ensuit que de 16 couples mariés, où les femmes sont âgées de 20 à 45 ans, 5 enfants naissent annuellement dans les villages. Il serait désirable de chercher la vraie valeur de ce rapport en se basant sur des nombres encore plus grands." In his *Introduction à la géographie générale* (Amsterdam, 1740), Struyck had already given the number of births and of married couples, but without computing the ratio (see *ibid.*, p. 245). In 1753, Struyck related also the number of births to the number of families (see *ibid.*, pp. 260, 303, 340). But this ratio had been established before him by Thomas Short. See *New Observations*, pp. 139, 237–238, 265–267.

[1] In the United States of America, 1924–1932, five such births (three to white girls and two to coloured girls) have been reported. See *Birth Statistics for the Birth Registration Area of the United States*, 1924, p. 169; 1925, p. 124; 1926, p. 128; 1927, p. 120; 1928, p. 166; 1929, p. 215; 1930, p. 232; 1931, p. 122; 1932, p. 114.

[2] In the Ukraine, 1926, three births to women of 62 years and one birth to a woman of 63 years. See *Statistika Ukraïni* (Series I), No. 154, p. 49.

TABLE 30.—BIRTHS TO WOMEN UNDER 15 YEARS OF AGE.

Country	Period	Births	
		Total	per Year
Australia[1]	1908–1933	891	34·3
Bulgaria	1898	13	13
	1899–1900[2]	24	12
	1901–1907	26	3·7
Canada[5]	1930–1931	160	80
Finland[3]	1881–1925	72	1·6
France	1907–1931	2,943	117·7
Italy[3]	1931	85	85
New Zealand[1]	1912–1933	104	4·7
Portugal	1930–1931	26	13
Spain	1922–1930	350	38·9
Sweden[3]	1891–1931	223	5·4
United States,[4] Whites	1917–1932	13,762	860·1
United States,[4] Coloured	1917–1932	14,390	899·4

this respect it has become customary to fix the lower limit of child-bearing age for statistical purposes at 15 years.

The upper limit is more flexible. The main problem here is: Are births to mothers over 50 numerous enough to justify fixing the limit for statistical purposes above 50 years? Tables 31 and 32 show for various countries the number of mothers over 50 years, and so far as possible the actual age of those mothers.

TABLE 31.—BIRTHS TO WOMEN OVER 50 YEARS OF AGE.

Country	Period	Births	
		Total	per Year
Australia[1]	1908–1933	181	7·0
Bulgaria	1898	901	901
	1899–1900[2]	2,016	1,008
	1901–1907	7,263	1,037·6
Canada[5]	1922–1925[6]	95	23·8
	1926–1931	179	29·8
Czechoslovakia	1925–1928	469	117·3
Denmark[3]	1878–1930	130	2·5
Estonia	1922–1933	92	7·7
Finland	1866–1932	2,190	32·7
France	1907–1931	1,254	50·2

[1] Excluding Aborigines.
[2] Live- and still-born.
[3] Confinements.
[4] Birth Registration Area.
[5] Excluding Yukon and North West Territories.
[6] Excluding also Province of Quebec.

TABLE 31.—BIRTHS TO WOMEN OVER 50 YEARS OF AGE—*continued.*

Country	Period	Births	
		Total	per Year
Greece[1]	1931	247	247
Hungary	1897	303	303
	1900–1918	3,427	180·4
	1919–1929	285	26·0
	1930–1932[1]	117	39
Latvia	1929–1931[1]	148	49·3
	1932–1933	118	59
Lithuania	1929–1933	423	84·6
New Zealand[2]	1912–1933	12	0·5
Norway	1871–1920[4]	1,422	49·0
Poland	1927–1928	1,648	824
Portugal	1930–1931	249	124·5
Serbia	1901–1910	297	29·7
Spain	1922–1930	9,160	1,017·8
Sweden[3]	1775–1835	1,958	32·1
	1836–1900	1,481	22·8
	1901–1931	186	6
Ukraine	1925–1929	5,181	1,036·2
United States,[5] Whites	1917–1932	2,040	127·5
United States,[5] Coloured	1917–1932	570	35·6

TABLE 32.—MOTHERS OVER 50 YEARS BY YEARS OF AGE.

Country	Period	50	51	52	53	54	55	56	57	58	59	60 and up	Total
Australia[2]	1908–33	98	34	25	12	5	7	—	—	—	—	—	181
Bulgaria	1898	537					364						901
	1899–00[1]	1,329					687						2,016
Denmark	1880–10				45				6				51
	1911–30	32	15	6	6	3			11				73
Estonia	1930–33				24				3				27
Finland[3]	1881–32	863	282	219	105	82	32	14	8	3	—	1[6]	1,609
France	1925–27	75	31	17	18	12	8	—	—	2	2	—	165
New Zealand[2]	1912–33	8	2	2	—	—	—	—	—	—	—	—	12
Sweden	1891–00	130	11	3	—	—	—	—	—	—	—	—	144
	1911–31	73	25	9	2	—	—	—	—	—	—	—	109
Ukraine	1925				927				262				1,189
	1926–28	1,497	190	243	134	107	200	75	47	48	23	71[7]	2,635
United States,[5] Whites	1917–23				886				145				1,031
	1924–32	454	159	139	93	76	—	—	—	—	—	—	921
United States,[5] Coloured	1917–23				193				27				220
	1924–32	206	54	44	17	25	—	—	—	—	—	—	346

[1] Live- and still-born. [2] Excluding Aborigines. [3] Confinements.
[4] Data lacking for 1877–1880, 1886–1888, 1893–1898, 1906–1909, 1912–1915.
[5] Birth Registration Area. [6] Sixty years.
[7] 1926: 14 of 60 years, 2 of 61, 3 of 62, and 1 of 63 years; for other calendar years not given separately.

From these figures it appears that the number of births to women over 50 was very small in practically all countries. Even in Bulgaria, where the figures were comparatively large, the proportion of those births was 6 per 1,000 only, and the actual number here was probably smaller than the reported one.[1] It does not, therefore, seem advisable to extend the limit of the child-bearing age for statistical purposes beyond 50 years.[2]

[1] See pp. 25–27.

[2] It should be noted, however, that so far there is no consensus of opinion about the proper limits of child-bearing age for statistical purposes. In the English official statistics the practice has varied. William Farr began by taking as child-bearing age the years from 15 to 45 (see *Fourth Report*, 1840–41, p. 137 ; *Eighth Report*, 1845, p. 37). Later on he stated that " the mothers of all the children that are born in the country are between the ages of 15 and 55," and " inferred from the Swedish returns that not more than 1 in 8 women who bear children is under the age of 20 or above the age of 40." He thereupon related (1) all legitimate births to the married women under 40, and all illegitimate births to the unmarried women from 20 to 40 ; (2) all legitimate births to the married women under 55, and all illegitimate births to the unmarried women from 15 to 55 ; (3) about seven-eighths of all births, of all legitimate births, and of all illegitimate births to the total, the married, and the unmarried women between 20 and 40 years (see *Fourteenth Report*, 1851, pp. xi–xiii). He followed a similar procedure in a number of subsequent reports (see *Eighteenth Report*, 1855, p. xxxiv ; *Twentieth Report*, 1857, pp. xiv–xv, l ; *Twenty-Seventh Report*, 1864, p. xviii ; *Thirty-Fifth Report*, 1872, p. xvii ; *Thirty-Seventh Report*, 1874, pp. xiv–xv), laying sometimes more stress on the age period 15 to 55 and sometimes on the age period 20 to 40, but in other reports of the same time again chose as age limits 15 and 45 years (see *Eighteenth Report*, 1855, p. xi ; *Nineteenth Report*, 1856, pp. ix, xii ; *Twenty-First Report*, 1858, p. xii ; *Twenty-Second Report*, 1859, p. xii ; *Thirty-First Report*, 1868, p. x ; *Thirty-Eighth Report*, 1875, p. xxvii), and 15 to 45 years have been considered the child-bearing age in all the reports of the Registrar-General from 1880 on.

In other countries preference, as a rule, was given in former times to the age period from 15 to 50 years, while in recent times it has become customary more and more to follow the example of England and to relate births to females between 15 and 45. The main cause for this change probably was the strong decrease of births to women between 45 and 50. There would, indeed, be no point in carrying in the denominator the dead weight of the women between 45 and 50, if they appeared with a negligible proportion of births only in the numerator. The unnecessary enclosure of the women between 45 and 50 would even impair the value of the general fertility rate, since the proportion of those women varies considerably from country to country : they constituted, for instance, in the Ukraine, 1926, 7·5 per cent only of the women between 15 and 50, as against 12·5 per cent in France, 1921. But the proportion of the births to women over 45 still exceeds 1 per cent of all births in many countries, and in some northern countries, like Norway and Lithuania, the ratio of births to females of 45 to 50 is higher than the ratio of births to females of 15 to 20. As a matter of fact, the number of births to females under 20 is rather small in most

If, then, child-bearing age is assumed to cover the period from 15 to 50 years, the general fertility rate is the number of births per 1,000 women of 15 to 50 years. This rate indicates how much the women of child-bearing age add to the population through births. It is evident that if the percentage of women of child-bearing age among the total population were always and everywhere the same, say 25 per cent, the general fertility rate would always and everywhere be four times as large as the birth rate, the trend of the general fertility rate would be exactly the same as that of the birth rate, and there would be no point in computing the general fertility rate. But, of course, the proportion of women at child-bearing age varies. In colonial populations it may be very small. For some years after Virginia had been permanently settled in 1607, there was no white female at all in the country. In the state of Colorado, as late as 1860, the females between 15 and 50 years constituted only 3·2 per cent of the total population.[1] In old countries, on the other hand, the proportion is much higher: for Europe the available statistics show variations between 21·2 (Bulgaria, 1892) and 29·2 per cent (Germany, 1929). Table 33 shows the percentages for various countries.[2]

While the influence of extensive and overwhelmingly male immigration on the proportion of women of child-bearing age is always conspicuous, the effect of other factors determining population growth is often not easily discernible. One might expect the proportion of women of child-bearing age to be large in countries with considerable emigration, but Ireland, in 1870, had the lowest proportion ever recorded for any country of Western and Northern Europe (23·9 per cent). One might expect a decrease of fertility such as occurred in

European and in numerous other countries, mainly because the number of married women under 20 is rather small. About 95 per cent of all children, as a rule, are born to women between 20 and 45 years, while the females between 20 and 45, as a rule, constitute about 70 per cent only of all females between 15 and 50. It may seem, therefore, advisable to relate the number of births either to the number of females between 15 and 50, or, if one wants to reduce the weight of the denominator, to relate the number of births to the number of females between 20 and 45.

[1] The total population consisted of 32,691 males and 1,586 females.

[2] See also Table III in the Appendix.

TABLE 33.—WOMEN OF CHILD-BEARING AGE PER CENT OF TOTAL POPULATION, 1750–1930.

1. *Western and Northern Europe.*

Year About	Belgium	Denmark	England and Wales	Scotland	Ireland	France	Germany	Holland	Norway	Sweden	Switzerland
1750	—	—	—	—	—	—	—	—	—	25·93	—
1775	—	—	—	—	—	—	—	—	—	26·90	—
1800	—	—	—	—	—	—	—	—	25·75	26·21	—
1825	—	—	—	—	—	—	—	—	24·95	25·19	—
1840	—	25·82	—	—	—	—	—	—	—	25·99	—
1845	25·16	25·82	—	—	—	—	—	—	25·50	25·94	—
1850	—	25·85	25·89	26·79	25·92	26·18	—	25·83	25·34	26·05	—
1855	25·36	25·40	—	—	—	—	—	—	24·73	25·97	—
1860	—	25·14	25·91	26·46	25·72	25·99	—	26·09	24·42	26·01	26·90
1865	24·44	—	—	—	—	—	—	—	24·73	25·57	—
1870	—	24·97	25·47	25·64	23·88	25·65	25·42	25·25	24·77	25·44	26·13
1875	—	—	—	—	—	25·47	25·06	—	24·84	25·00	—
1880	23·95	24·47	25·38	25·44	24·45	25·33	24·81	24·03	24·59	25·06	25·55
1885	—	—	—	—	—	—	—	—	24·32	24·44	—
1890	24·49	24·30	26·16	25·72	24·96	25·65	24·97	23·90	24·44	24·04	25·48
1895	—	—	—	—	—	25·85	—	—	24·34	23·91	—
1900	25·35	24·91	27·47	26·63	25·74	25·73	25·03	24·42	24·34	24·06	25·80
1905	—	—	—	—	—	25·81	—	—	—	—	—
1910	25·86	25·02	27·69	26·71	24·60	25·87	25·32	24·82	24·64	24·24	26·02
1915	—	—	—	—	—	—	—	—	—	24·49	—
1920	27·77	25·97	28·27	27·38	—	27·59	28·83	25·49	25·26	25·22	27·72
1925	—	—	28·19	—	24·55	27·25	28·99	—	—	26·01	—
1930	—	26·99	28·01	26·98	—	26·67	29·02	25·94	26·26	26·67	28·15

2. *Other Countries.*

Year About	Austria	Bulgaria	Finland	Greece	Hungary	Italy	Portugal	Spain	Australia	New Zealand	Canada	United States
1750	—	—	24·00	—	—	—	—	—	—	—	—	—
1775	—	—	25·24	—	—	—	—	—	—	—	—	—
1800	—	—	26·02	—	—	—	—	—	—	—	—	—
1825	—	—	26·24	—	—	—	—	—	—	—	—	—
1850	—	—	25·47	—	—	—	—	—	—	—	—	24·11
1855	—	—	—	—	—	—	—	—	—	—	—	—
1860	—	—	—	—	—	25·98	—	27·04	—	—	—	24·34
1865	—	—	25·62	—	—	—	26·60	—	—	—	—	—
1870	26·46	—	26·60	24·32	25·67	25·32	—	—	—	—	—	24·99
1875	—	—	25·82	—	—	—	—	26·63	—	19·87	—	—
1880	25·75	—	25·37	24·17	25·91	25·19	25·98	—	22·68	21·16	24·47	24·67
1885	—	—	24·64	—	—	—	—	25·34	—	22·23	—	—
1890	25·45	21·34	24·43	24·35	24·59	—	25·55	—	23·42	22·87	24·69	25·19
1895	—	—	—	—	—	—	—	—	—	24·33	—	—
1900	25·05	21·84	24·50	—	24·59	24·02	25·53	25·28	24·94	25·56	24·70	25·49
1905	—	22·09	—	25·13	—	—	—	—	—	25·86	—	—
1910	24·87[1]	22·33	24·44	—	24·39[2]	24·59	25·73	25·00	26·23	25·96	23·96	25·97
1915	—	—	—	—	—	—	—	—	—	26·87	—	—
1920	—	24·85	25·92	25·60	27·40	25·69	26·64	25·83	25·90	26·36	24·36	25·95
1925	28·95	25·50	—	—	—	—	—	—	—	26·47	—	—
1930	28·64	—	26·86	26·35	27·90	26·41	26·42	—	26·10	26·36	24·77	26·58

[1] Present territory, 26·05.

[2] Present territory, 24·58.

Western and Northern Europe before the World War to result in an increase of the proportion of women of child-bearing age, but the decrease in the proportion of children was offset by the increase in the proportion of people over 50 years, due to a reduction of mortality, and the proportion of women of child-bearing age did not alter essentially. Nor was there a marked change in their proportion since the war, because the decrease in the proportion of children in the neutral countries was offset by a slight increase in the proportion of children in the ex-belligerent countries where fertility had been particularly low during the war. Since 1929 there is, moreover, another factor counterbalancing the effect of the low fertility of recent years upon the proportion of women at child-bearing age in Western and Northern Europe, inasmuch as the small number of girls born in the war is entering child-bearing age and thereby is reducing the proportion of women of that age. Taking Western and Northern Europe as a whole, the proportion from 1860 to 1910 only oscillated between 25·0 per cent (1880) and 25·9 per cent (1860 and 1910). By 1920 it had increased to 27·8 per cent (due to the decrease of fertility and to the increase of male mortality during the war). Since 1920 it has remained about stationary.

There are, then, cases like that of Western and Northern Europe as a whole, where from 1860 to 1910 the general fertility rate follows the same trend as the birth rate, and where the general fertility rate does not therefore convey a more accurate picture of the trend of fertility than the birth rate. But even in this period of comparative stability the trend of the fertility rate in individual countries differed considerably from that of the birth rate. While from 1860–61 to 1910–11 the birth rate in England dropped from 34·5 to 24·7, and similarly in Sweden from 33·7 to 24·3, the fertility rate of England dropped from 133 to 89 and that of Sweden from 130 to 100, the reason for this discrepancy being that the proportion of women at child-bearing age rose in England from 25·9 to 27·7 per cent, while the proportion in Sweden simultaneously decreased from 26·0 to 24·2 per cent. It may be mentioned incidentally that the tendency was the opposite

in the following two decades since the proportion of women at child-bearing age hardly changed at all in England, while in Sweden it increased to 26·7 per cent. The birth rate actually decreased from 1910–11 to 1930–31 in England from 24·7 to 16·1, in Sweden from 24·3 to 15·1, while the general fertility rate decreased in England from 89 to 57, in Sweden from 100 to 57.

3. Specific Fertility Rates

The general fertility rate indicates how much the women of child-bearing age add to the population through births. But it is calculated without regard to the specific age composition of the women in child-bearing age and two populations with precisely the same fertility in each year of age will show quite different general fertility rates if the proportion of older women among the females of child-bearing age differs much. If, for instance, the women in the Ukraine actually had the low fertility of women in England, they would still show a much higher general fertility rate because the women over 35 years constitute in the Ukraine 27 per cent only of all women between 15 and 50 years (1926) as against 39 per cent in England (1931). Since the general fertility rate is calculated without regard to the specific age composition of the women of child-bearing age, it does not then, after all, afford an adequate gauge for the measurement of the actual fertility of those women.

The first to realize that in order to measure fertility accurately it is necessary to compute fertility rates for the individual age groups of mothers apparently was the Swedish astronomer Per Wargentin. At the time when he was Secretary of the Swedish Academy of Science and the moving spirit of the Swedish Statistical Commission,[1] the Swedish statistical records began (1775) to show the mothers bearing children by

[1] The *Tabellkommissionen* was established in 1756, and replaced in 1858 by the Central Bureau of Statistics. See Westergaard, Harald, *The Official Vital Statistics of the Scandinavian Countries and the Baltic Republics* (League of Nations, Health Organisation, Statistical Handbooks Series, No. 6), pp. 10, 15, Geneva, 1926.

quinquennial age groups. On the basis of these records, the Secretary of the Statistical Commission, H. Nicander, computed specific fertility rates according to age by relating the average annual number of deliveries in 1780–1795 for each quinquennial age group from 15 to 55 years to the mean number of living females. He published the results in the Transactions of the Swedish Academy (1800),[1] and they were made known to a larger public in 1815 by Joshua Milne.[2]

Specific fertility rates for quinquennial age groups, and even for individual years of age, have since been computed for an ever-increasing number of countries, but for about a century the usefulness of such rates for determining fertility was rather limited. The student will easily understand the reason for it by looking at the following table, which gives specific fertility rates for the Ukraine, Bulgaria, and Norway :

TABLE 34.—QUINQUENNIAL FERTILITY RATES.

Country	Period	15–19 Years	20–24 Years	25–29 Years	30–34 Years	35–39 Years	40–44 Years	45–49 Years
Ukraine	1926–27	41·2	236·6	259·0	224·4	158·4	83·4	25·0
Bulgaria	1921–26	35·1	246·4	272·7	208·7	155·4	78·9	35·8
Bulgaria	1926–27	36·2	225·6	242·6	188·8	131·4	64·0	30·6
Norway	1874–76	7·2	101·3	208·9	238·6	212·3	134·8	31·1

What, in fact, does this table show ? It shows that the fertility rate was lower in Bulgaria, 1921–1926, than in the Ukraine, 1926–1927, for the age groups 15 to 20 and 30 to 45, but higher for the groups 20 to 30 and 45 to 50. It shows that the fertility rate was lower in Norway, 1874–1876, than in Bulgaria, 1926–1927, for the groups 15 to 30, but higher for the groups 30 to 50.

The birth rate was noticeably lower in Bulgaria, 1921–1926 (38·8), than in the Ukraine, 1926–1927 (41·2), and the general fertility rate was slightly lower in Bulgaria (154) than in the Ukraine (156). Yet how could one see from the quinquennial fertility rates (not to mention annual rates) that fertility was actually *higher* in Bulgaria than in the Ukraine ?

[1] See *Kongl. Svenska Vetenkaps Academiens Nya Handlingar*, vol. xxi, 1800, p. 323.

[2] See Milne, *A Treatise on the Valuation of Annuities and Assurances on Lives and Survivorships*, etc., vol. ii, pp. 487–488, 582.

The birth rate was much lower in Norway, 1874–1876 (31·2), than in Bulgaria, 1926–1927 (35·2), and the general fertility rate was noticeably lower in Norway (125) than in Bulgaria (138). But who could tell from the quinquennial fertility rates that fertility was actually *higher* in Norway than in Bulgaria?

Specific fertility rates by age, then, are no more and no less than the proper basic material for a measurement of fertility as a whole. In order to become really useful they have to be fused into one numerical expression.

4. Total Fertility

An easy solution of the problem of combining annual fertility rates into one numerical expression was presented by the author in an address at the International Congress on Hygiene and Demography of 1907.[1] I simply proposed to add up the annual fertility rates.[2] The sum thus obtained—which may be called the *total fertility*—indicates exactly how many children, with fertility as it is, would be born to 1,000 women arriving at the age of child-bearing if none of those 1,000 women died before having passed through child-bearing age. The sum, for instance, of the annual fertility rates in the Ukraine, 1926–1927 (0·2+1·6+14·7, etc.), is 5,134·6, and means that with fertility as it was in 1926–1927, 5,135 children would be born to 1,000 women passing through child-bearing age (see Table 35).

Nicander knew the age of mothers only for quinquennial periods, and births in most countries still are usually published only by quinquennial age groups of mothers. Is it, then, safe to compute total fertility from quinquennial fertility rates?

[1] See *Bericht über der XIV. Internationalen Kongress für Hygiene und Demographie*, Berlin, 23–29 September, 1907, vol. iii, pp. 1472–1484; reprinted in *Jahrbücher für Nationalökonomie und Statistik*, Third Series, vol. xxxv, pp. 229–241.

[2] As late as December, 1905, Newsholme and Stevenson complained that fertility rates by age "render a view *toute ensemble* almost impracticable" ("The Decline of Human Fertility," *Journal of the Royal Statistical Society*, vol. lxix, year 1906, p. 38). The sum of those rates provides such a view.

TABLE 35.—SPECIFIC FERTILITY RATES OF THE UKRAINE, 1926–1927, AND OF AUSTRALIA, 1920–1922.

Years of Age	Ukraine[1]			Australia				
	Females 1 Jan., 1927	Yearly Births, 1926–1927	Births per 1,000 Females	Females 4 April, 1921	Yearly Births, 1920–1922	Births per 1,000 Females	Yearly Female Births, 1920–1922	Female Births per 1,000 Females
12	—	—	—	51,374	1	0·019	—	—
13	—	—	—	51,545	5	0·097	3	0·058
14	—	—	—	49,860	27	0·542	12	0·241
15	375,045	77	0·205	48,205	78	1·618	39	0·809
16	364,914	590	1·617	47,966	319	6·651	152	3·169
17	354,791	5,198	14·651	44,768	840	18·763	399	8·913
18	344,633	21,306	61·822	45,668	1,812	39,678	859	18·810
19	334,437	45,934	137·347	42,673	3,009	70·513	1,482	34·729
20	324,231	62,954	194·164	47,648	4,169	87·496	2,006	42·100
21	314,060	72,374	230·446	48,308	5,502	113·894	2,652	54·898
22	303,968	74,852	246·250	45,381	6,527	143·827	3,167	69·787
23	293,970	75,261	256·016	44,988	7,230	160·710	3,520	78·243
24	284,044	74,253	261·414	46,958	7,780	165·680	3,760	80·072
25	274,135	72,233	263·494	47,393	8,060	170·067	3,920	82·713
26	264,185	69,485	263·016	47,644	8,396	176·224	4,087	85·782
27	254,157	66,195	260·449	48,041	8,149	169·626	3,966	82·555
28	244,058	62,525	256·189	47,953	8,172	170·417	3,955	82·477
29	233,953	58,588	250·426	45,969	7,768	168·983	3,761	81·816
30	223,958	54,484	243·278	47,444	7,549	159·114	3,650	76·933
31	214,221	50,288	234·748	42,609	6,484	152·174	3,151	73·952
32	204,884	46,067	224·844	46,882	6,545	139·606	3,186	67·958
33	196,065	41,878	213·592	42,974	5,812	135·245	2,831	65·877
34	187,829	37,762	201·045	41,583	5,373	129·211	2,618	62·958
35	180,184	33,764	187·386	40,418	4,865	120·367	2,374	58·736
36	173,080	29,914	172·833	40,518	4,429	109·309	2,148	53·014
37	166,434	26,242	157·672	37,259	3,782	101·506	1,869	50·162
38	160,149	22,638	141·356	37,136	3,543	95·406	1,741	46·882
39	154,142	19,517	126·617	34,613	2,930	84·650	1,419	40·996
40	148,355	16,500	111·220	36,621	2,358	64·389	1,146	31,294
41	142,764	13,730	96·173	33,394	1,671	50·039	818	24·495
42	137,380	11,219	81·664	31,582	1,414	44·772	692	21·911
43	132,235	8,969	67·826	29,576	948	32·053	453	15·316
44	127,369	6,987	54·856	30,049	561	18·670	281	9·351
45	122,816	5,271	42·918	29,194	321	10·995	158	5·412
46	118,597	3,818	32·193	27,281	148	5·425	74	2·713
47	114,708	2,624	22·875	25,892	73	2·819	37	1·429
48	111,121	1,676	15·083	28,388	37	1·303	16	0·564
49	107,798	964	8·943	24,903	10	0·402	5	0·201
50	—	—	—	27,289	2	0·073	1	0·037
51	—	—	—	24,206	—	—	—	—
52	—	—	—	24,115	1	0·041	—	—
Total	—	1,196,137	5,134·628	—	136,700	3,122·374	66,408	1,517·363

If the number of women at each year within the quinquennial age group were the same, or if the fertility rates were alike at all ages within the quinquennial period, total fertility might be as accurately shown by multiplying each quinquennial rate by five and adding the products as by adding the fertility rates of the individual years of age. But the number of women at each year of age varies a great deal, and the fertility rates vary

[1] Adjusted figures ; see Kuczynski, *Fertility and Reproduction*, pp. 9–11, New York, 1932.

still more. In the Ukraine, 1926–1927, for instance, the females of 19 years were 11 per cent less numerous than the females of 15 years, the births to females of 19 years were 597 times as numerous as the births to females of 15 years; the fertility rate of the females of 19 years was 669 times as large as the fertility rate of the females of 15 years. In spite of the great differences in the annual fertility rates, the quinquennial fertility rates would convey a true picture if the number of females at each year were the same. But as their number is decreasing, the quinquennial fertility rate is unduly small, since in computing it the weight of the high fertility rate of the last year is too light. In the normal case, where the number of women at each year of age is decreasing, the quinquennial fertility rate will indeed be unduly small for that period of life when the fertility rate increases, while it will become unduly large whenever the fertility rate decreases. In the Ukraine the quinquennial fertility rates are thus unduly low for the two youngest age groups (15 to 20 and 20 to 25 years), while they are unduly high for the three oldest age groups (35 to 50 years). To this extent the quinquennial rates are inaccurate. But since the deviations practically compensate each other, they are hardly noticeable in the totals. The following table shows for the Ukraine, 1926–1927, total fertility derived (*a*) from the annual fertility rates; (*b*) from quinquennial fertility rates.

TABLE 36.—SPECIFIC FERTILITY RATES BY QUINQUENNIAL AGE GROUPS IN THE UKRAINE, 1926–1927.

Age Groups	Females 1 Jan., 1927	Yearly Births, 1926–1927	Births per 1,000 Females	
			(*a*)	(*b*)
15–19	1,773,820	73,105	215·64	206·07
20–24	1,520,273	359,694	1,188·29	1,182·99
25–29	1,270,488	329,026	1,293·57	1,294·88
30–34	1,026,957	230,479	1,117·51	1,122·14
35–39	833,989	132,075	785·87	791·83
40–44	688,103	57,405	411·74	417·12
45–49	575,040	14,353	122·01	124·80
Total . .	7,688,670	1,196,137	5,134·63	5,139·83

(*a*) Sum of annual fertility rates.
(*b*) Quinquennial fertility rates multiplied by five.

Total fertility derived from annual rates is 5,134·6, and total fertility derived from quinquennial rates is 5,139·8. The difference is 0·1 per cent, and therefore negligible.[1] It may become much larger if decennial fertility rates are substituted for quinquennial rates.[2] But whenever births are known by quinquennial age groups no risk is involved in computing total fertility by multiplying the quinquennial fertility rates by five and adding the products.

5. Gross Reproduction Rate

Total fertility includes births both of boys and of girls. For studies of the trend of fertility it is advisable to restrict the investigation to the births of females, the potential future mothers. The best method, then, would be to relate the females borne by mothers of each specific year of age (or of each quinquennial age group) to the total number of women of that age. The results of such a computation for Australia, 1920–1922, are shown in the last column of Table 35. It appears that fertility, measured by female births, was 1,517·4. That is, the total number of girls born to 1,000 women passing through child-bearing age would be 1,517·4, and 1·517 would represent the *gross reproduction rate*.

But the births, according to age of mothers, are seldom at the same time classified according to sex. This would be a serious impediment to the computation of the gross reproduction rate, if the sex ratio of the newly-born differed materially for different ages of mothers. This, however, is not the case, and it, therefore, is not necessary to compute specific fertility rates based on female births alone. The total yearly average number of births in Australia, 1920–1922, was 136,700, of whom 70,292 were boys and 66,408 were girls. Total fertility, measured by all births, was 3,122·4. If this figure is reduced in the proportion of the female births to all mothers fertility would appear to be $3{,}122{\cdot}4 \times \frac{66{,}408}{136{,}700} = 1{,}516{\cdot}8$.

[1] For a similar result in the case of Sweden, see *The Balance of Births and Deaths*, vol. i, p. 26.

[2] See *Fertility and Reproduction*, pp. 12–13.

The indirect method deriving the gross reproduction rate from total fertility (comprising both boys and girls) thus leads practically to the same result as the direct method which excludes male births. In order to make comparisons easier Table 37, therefore, shows fertility rates based on the births of both sexes.[1] In addition to the fertility rates by quinquennial age groups are given the total fertility, that is, the sum of the quinquennial fertility rates multiplied by five, which indicates the number of children born [2] to 1,000 women, and the gross reproduction rate, that is, the number of live-born girls born to each woman. Table 38 summarizes the gross reproduction rates since 1870.[3]

The highest gross reproduction rate which we have found for any large country was for the Ukraine in 1896–1897. It amounted to 3·65. By 1926–1927 it had dropped to 2·49. Fifty years ago the gross reproduction rate for Western and Northern Europe as a whole was about two. By 1928 it had fallen to about one. In 1933 it was about 0·9. This means that according to present fertility not more than 90 girls are born to 100 newly-born girls passing through child-bearing age. With present fertility the population of Western and Northern Europe is doomed to die out even if every newly-born girl reached the age of 50. Within this area the gross reproduction rate still exceeds one in Holland and Denmark; it is below one in England, Germany, and Sweden. It is also below one in Austria and Estonia.

The gross reproduction rate is the best single figure to convey

[1] For the basic data, *i.e.* the mean number of females and the yearly number of births by quinquennial age groups, see Tables IV and V in the Appendix.

[2] The figures refer, as the case may be, to live-born children, live- and still-born children, or confinements.

[3] We have omitted countries for which we have data only for one single period. We have included, on the other hand, (1) figures for Sweden for each single year from 1921 to 1930 (which we have not given in Table 37 in order to save space); (2) figures for England, 1921–1933, which we have computed by assuming that the English fertility rates in 1921 were proportionally the same as those for Sweden in 1921–1922, etc. (England, 1922=Sweden, 1923; E., 1923=S., 1924; E., 1924=S., 1925; E., 1925, 1926=S., 1926; E., 1927, 1928=S., 1928; E., 1929, 1930=S., 1930; E., 1931–1933=S., 1931); (3) figures for several other countries for 1933, which we have roughly estimated. A parenthesis indicates that the age of mothers at birth was not known at all, or known only for part of the country.

TABLE 37.—FERTILITY RATES BY QUINQUENNIAL AGE GROUPS, 1871–1933.

Period	15–19 Years	20–24 Years	25–29 Years	30–34 Years	35–39 Years	40–44 Years	45–49 Years	Total Fertility	Gross Reproduction Rate
1. WESTERN AND NORTHERN EUROPE									
Denmark[1]									
1878–84	14·1	132·5	239·7	244·5	190·3	95·0	10·7	4,633·4	2·220
1885–94	15·5	132·6	233·7	224·8	183·4	90·0	9·2	4,446·1	2·140
1895–00	17·3	140·3	224·1	209·0	170·0	78·9	8·2	4,238·9	2·042
1901–05	20·1	143·1	225·3	198·1	150·0	66·9	7·3	4,054·2	1·954
1906–10	24·5	148·4	208·2	182·6	135·5	60·8	5·9	3,829·5	1·851
1911–15	23·9	137·6	187·8	161·4	119·6	54·2	5·5	3,450·1	1·671
1916–20	22·1	128·6	173·5	148·1	106·5	47·8	4·6	3,156·1	1·523
1921–25	24·0	121·2	160·9	129·7	93·1	40·7	4·1	2,868·1	1·384
1926–30	22·9	107·7	134·0	110·1	73·5	31·2	3·1	2,412·8	1·166
France									
1892–97[2]	28·5	131·8	179·4	141·8	92·3	39·1	6·7	3,099·0	1·447
1898–03[2]	27·8	141·2	169·9	128·6	86·8	35·7	5·7	2,978·4	1·393
1904–07[2]	28·3	138·1	158·2	121·7	76·0	32·7	5·1	2,801·1	1·310
1908–13[2]	28·4	139·3	150·1	109·1	70·8	27·2	2·7	2,638·1	1·232
1914–19[2 3]	15·0	73·7	88·5	72·8	53·3	23·3	2·3	1,644·7	0·766
1920–23	24·0	131·4	153·3	107·2	64·1	24·1	2·3	2,532·1	1·233
1925–27	27·2	129·9	134·3	98·7	56·4	20·6	1·9	2,344·7	1·146
1928–31	29·0	127·4	126·7	90·9	53·4	18·7	1·8	2,239·7	1·096
Germany									
Nine States[2 4]									
1881–90	18·8	177·2	277·6	238·3	182·2	80·2	10·2	4,922·3	—
1891–00	20·7	182·7	275·6	231·4	166·5	69·7	8·2	4,773·8	—
1901–10	23·3	176·0	260·8	198·5	138·1	59·0	6·4	4,310·1	—
Saxony									
1911–14[2]	28·7	159·9	182·2	125·1	89·9	37·9	3·1	3,134·1	1·472
1915–19[2]	10·1	71·8	98·5	73·4	53·3	21·6	2·0	1,653·5	0·772
1920–23[2]	18·3	124·5	149·5	108·0	63·0	23·5	1·9	2,443·4	1·141
1924–26	19·0	98·3	110·4	77·2	44·2	16·0	1·2	1,831·5	0·891
1927–30	22·8	93·9	97·2	65·0	35·6	12·9	0·9	1,641·1	0·796
1931[2]	22·7	81·4	81·3	53·1	28·9	10·5	0·7	1,393·2	0·654
Prussia[2]									
1930–32	19·8	89·1	110·4	81·3	49·6	19·8	2·3	1,861·5	0·873
Whole Country[5]									
1881–90[2]	20·0	188·8	295·6	253·8	194·0	85·5	10·9	5,242·8	2·459
1891–00[2]	21·7	192·2	289·9	243·4	175·1	73·3	8·6	5,021·0	2·366
1901–10[2]	24·3	183·9	272·4	207·3	144·2	61·6	6·7	4,502·2	2·126
1924–26	19·0	111·8	141·1	104·0	60·5	22·7	2·0	2,305·2	1·116
1929	18·1	95·8	118·1	88·9	55·3	22·0	2·5	2,003·6	0·971
1931	20·7	86·7	104·7	76·5	47·1	18·2	1·9	1,777·9	0·862
Norway									
1871–76	6·6	98·7	205·2	233·3	204·6	129·7	32·4	4,552·2	2·221
1881–85	7·3	101·1	207·5	230·6	204·2	128·1	29·5	4,542·1	2·202
1889–92	7·3	97·7	199·4	224·1	203·4	123·5	28·3	4,418·6	2·142
1899–05	11·2	109·8	203·7	210·8	182·1	110·1	21·7	4,246·9	2·064
1910–11	10·5	103·9	184·5	187·8	164·7	92·5	18·0	3,809·5	1·853
1916–20	11·0	103·0	167·6	170·8	141·5	79·4	14·1	3,437·2	1·661

TABLE 37.—FERTILITY RATES BY QUINQUENNIAL AGE GROUPS, 1871–1933—*continued.*

Period	15–19 Years	20–24 Years	25–29 Years	30–34 Years	35–39 Years	40–44 Years	45–49 Years	Total Fertility	Gross Reproduction Rate
				Sweden[1]					
1871–75	9·1	105·9	207·1	233·0	203·1	121·3	18·1	4,488	2·147
1876–80	10·0	106·9	209·9	233·6	204·7	117·6	19·0	4,508	2·163
1881–85	10·3	105·2	201·4	225·1	195·2	113·8	16·9	4,340	2·081
1886–90	10·8	107·4	198·5	218·7	190·4	108·0	16·5	4,252	2·049
1891–95	11·6	107·9	193·4	208·8	180·1	102·7	14·4	4,094	1·968
1896–00	14·7	115·7	194·6	202·1	172·4	96·9	12·7	4,045	1·944
1901–05	15·9	119·5	193·3	193·6	159·7	87·8	11·5	3,907	1·881
1906–10	18·9	121·9	186·3	184·3	149·3	78·9	10·0	3,748	1·799
1911–15	19·5	113·3	163·3	158·3	130·4	69·2	8·1	3,310·6	1·594
1916–20	16·9	105·5	148·7	140·0	111·0	58·7	7·3	2,990·7	1·414
1921–25	17·9	97·2	132·2	120·3	93·5	48·2	6·1	2,576·7	1·239
1926–30	17·8	83·0	106·3	94·9	70·9	35·0	4·3	2,061·3	0·992
1931	18·2	79·8	98·7	86·0	60·9	28·5	3·6	1,878·1	0·900
				2. EASTERN AND SOUTHERN EUROPE					
				Austria					
1895–00	28·4	181·1	265·2	222·4		53·5		5,113·7	2·485
1901–05	27·4	176·4	260·1	210·4		53·4		4,919·2	2·393
1906–10	28·4	173·2	244·9	196·6		49·5		4,660·4	2·266
1913	25·5	156·6	218·7	171·5		42·6		4,114·9	1·999
1928	25·1	94·2	105·3	88·1	59·6	14·2		1,999·1	0·969
1931–32	27·2	87·6	94·2	76·5	50·0	11·1		1,787·0	0·865
				Bulgaria					
1901–05	23·5	288·6	312·2	309·4	204·3	121·0	55·5	6,572·9	3·176
1906–10	23·5	291·7	307·3	290·1	211·8	124·1	56·1	6,522·3	3·155
1921–26	35·1	246·4	272·7	208·7	155·4	78·9	35·8	5,164·6	2·502
1926–27	36·2	225·6	242·6	188·8	131·4	64·0	30·6	4,596·3	2·217
				Czechoslovakia					
1920–21	21·8	153·2	200·3	155·1	107·8	45·2	6·8	3,451·3	1·664
				Estonia					
1922–23	9·4	89·8	138·4	121·1	88·9	41·9	6·3	2,478·6	1·204
				Finland[1]					
1871–75	18·7	149·9	239·0	252·9	202·6	111·4	19·8	4,971·8	2·388
1876–80	20·2	153·6	238·6	244·0	209·5	119·5	19·3	5,023·3	2·420
1881–85	20·0	151·7	231·3	238·6	200·5	121·3	19·3	4,914·2	2·363
1886–90	18·3	155·7	236·8	240·5	204·4	121·2	20·7	4,988·1	2·400
1891–00	17·3	154·8	211·4	237·8	192·7	115·6	17·7	4,740	2·278
1901–10	16·2	138·5	211·9	216·0	184·9	106·0	16·0	4,447·6	2·140
1911–20	14·6	116·7	167·7	165·6	142·3	86·0	13·1	3,579·9	1·716
1921–30	14·2	107·8	149·5	133·9	107·8	61·7	9·6	2,923·0	1·402
				Hungary					
1900–01	56·8	259·0	280·0	197·6		44·7		5,353·8	2·605
1902–07	56·7	257·9	263·3	183·5		42·4		5,105·2	2·477
1908–13	59·4	250·3	252·2	177·4		37·9		4,924·6	2·396
1920–21	43·6	207·3	205·6	126·6		26·9		3,792·7	1·829
1930–31[2]	41·8	162·1	155·7	97·5		16·7		2,922·4	1·338
				Italy					
1931	29·5[8]	138·7[9]	172·3	152·5	113·8	52·0	6·3	3,216·1	1·570

TABLE 37.—FERTILITY RATES BY QUINQUENNIAL AGE GROUPS, 1871–1933—*continued.*

Period	15–19 Years	20–24 Years	25–29 Years	30–34 Years	35–39 Years	40–44 Years	45–49 Years	Total Fertility	Gross Reproduction Rate
Latvia[2]									
1929	9·7	82·9	126·0	110·7	77·5	29·8	5·9	2,212·1	1·061
Lithuania									
1928	10·1	105·5	211·4	216·0	143·1	59·0	15·2	3,801·5	1·850
Portugal									
1930–31	23·4	151·4	199·3	174·3	143·0	65·7	11·7	3,844·0	1·868
Russia									
European Russia proper (50 provinces)									
1896–97[6]	30	309	334	331	219	130	59	7,060	3·44
European R.S.F.S.R.									
1926–27[7]	40	275	286	233	177	87	24	5,610	2·72
Ukraine									
1896–97[6]	32	328	355	352	232	138	63	7,500	3·65
1926–27	43·1	237·7	258·7	223·5	157·2	82·3	24·4	5,134·6	2·485
Serbia									
1900–01	81·3[8]	277·0[9]	364·8	242·7	137·2	58·1	10·4	5,662·2	2·750
3. OTHER COUNTRIES									
Canada (excluding Yukon and North West Territories)									
1921–25[10]	35·6	149·2	171·9	144·7	103·4	45·5	5·7	3,279·7	1·596
1926–27[10]	32·8	135·9	156·2	134·0	93·3	41·7	5·3	2,995·9	1·455
1926–27	30·8	143·4	178·1	155·0	113·6	52·4	6·6	3,400·0	1·649
1931	30·0	137·3	175·2	145·3	103·0	43·9	5·3	3,199·9	1·555
Australia[11]									
1908–13	27·2	132·9	185·9	165·1	125·0	55·3	6·5	3,438·6	1·677
1920–22	27·6	134·3	171·1	143·1	102·2	42·0	4·2	3,122·4	1·517
1932–33	25·6	103·7	126·7	94·8	60·0	25·4	2·8	2,195·4	1·068
New Zealand[11]									
1911–15	20·9	120·4	177·7	156·8	107·9	44·9	5·4	3,169·6	1·541
1916–20	15·8	109·6	163·7	148·9	105·5	43·5	5·1	2,960·2	1·445
1921–22	17·1	122·5	169·8	142·5	95·7	38·6	4·6	2,954·5	1·442
1923–29	18·7	111·2	157·5	127·9	84·5	32·7	3·4	2,679·1	1·301
1930–31	18·8	106·4	144·6	113·8	72·0	27·2	2·8	2,428·2	1·179
1932	18·3	97·5	132·4	103·5	65·5	24·8	2·4	2,222·1	1·077
1933	16·8	94·7	130·6	100·2	61·8	23·4	2·7	2,151·1	1·053

[1] Confinement rates. [2] Live- and still-birth rates.
[3] 77 provinces only (excluding 10 occupied provinces).
[4] Hesse, Oldenburg, Brunswick, Saxony-Weimar, Saxony-Altenburg, and the Schwarzburg and Reuss principalities.
[5] Derived from data comprising part of the country only.
[6] Derived from data for Bulgaria. [7] Derived from data for Ukraine.
[8] 15 to 20 years. [9] 21 to 24 years. [10] Excluding also Province of Quebec.
[11] Excluding Aborigines.

a measure of fertility. But its computation presupposes the knowledge of the births by age of mothers while the general fertility rate does not. Since the age of the mothers still is not ascertained in some countries, like England, the question arises: With what degree of accuracy may the gross reproduction rate be derived from the general fertility rate? If we designate by n_{15}, n_{16}, etc., the female births to mothers of 15, 16, etc., years, and by f_{15}, f_{16}, etc., the number of living females of 15, 16, etc., years, a general fertility rate computed by relating the total number of female births to the living females of 15 to 49 years and multiplied by 35 would be equal to the gross reproduction rate, if

$$35\times\frac{n_{15}+n_{16}+\ \ldots\ +n_{49}}{f_{15}+f_{16}+\ \ldots\ +f_{49}}=\frac{n_{15}}{f_{15}}+\frac{n_{16}}{f_{16}}+\ \ldots\ \frac{n_{49}}{f_{49}}$$

This, of course, is not necessarily so.[1] Table 39 shows the gross reproduction rates in various countries: (*a*) computed from the quinquennial fertility rates; (*b*) computed from the general fertility rates; and the difference between the results of those two computations.

In the case of Sweden, the two rates were almost identical in 1776–1780 and 1796–1800. Those computed from the general fertility rates were higher in 1781–1795, 1811–1830, 1851–1865, and 1911–1930. For some periods the differences are rather large: in 1786–1790 and 1926–1930 rate (*b*) was by 3·5 or 3·6 per cent higher than rate (*a*); in 1836–1845 and 1871–1885 rate (*b*) was by 3·2 to 4·3 lower than rate (*a*). In 1786–1790 and 1876–1880 rate (*a*) was 2·0048 and 2·1634, while rate (*b*) was 2·0754 and 2·0704; that is, the more accurate rate (*a*) increased by 8 per cent, while rate (*b*) showed a slight decrease. The cause for this discrepancy is that the proportion of the most fertile age groups from 25 to 39 years was much smaller in 1876–1880 than in 1786–1790.[2] In Denmark and

[1] Taking the first two years,

$$2\times\frac{n_{15}+n_{16}}{f_{15}+f_{16}}=\frac{n_{15}}{f_{15}}+\frac{n_{16}}{f_{16}}+\frac{(f_{15}-f_{16})(n_{15}f_{16}-n_{16}f_{15})}{(f_{15}+f_{16})f_{15}f_{16}}$$

The extent of the error depends thus on the value of the third item on the right side of the equation.

[2] See *Balance of Births and Deaths*, vol. i, p. 30.

TABLE 38.—GROSS REPRODUCTION

Years	Denmark	England	France	Germany	Norway	Sweden	Austria
1871–1875	——	——	——	——	2·221	2·147	——
1876	——	——	——	——		2·163	——
1877	——	——	——	——	——		——
1878–1880	2·220	——	——	——	——		——
1881–1884		——	——		2·202	2·081	——
1885	2·140	——	——	(2·459)	——		——
1886–1888		——	——			2·049	——
1889–1890		——	——		2·142		——
1891		——	——			1·968	——
1892		——	1·447		——		——
1893–1894		——			——		——
1895	2·042	——		(2·366)	——	1·944	2·485
1896–1897		——			——		
1898		——			——		
1899		——	1·393		2·064		
1900		——				1·881	2·393
1901	1·954	——		(2·126)	——		
1902–1903		——	1·310		——	1·799	2·266
1904–1905		——			1·853		
1906–1907	1·851	——			——		
1908–1909		——	1·232		——	1·594	1·999
1910		——			——		——
1911	1·671	——			——		——
1912		——			——		——
1913		——			1·661	1·414	——
1914–1915		——	0·766				
1916–1919	1·523	——					
1920		——					
1921	1·384	(1·326)	1·233	——	——	1·413	——
1922		(1·213)		——	——	1·280	——
1923		(1·176)		——	——	1·221	——
1924		(1·120)	——		——	1·169	——
1925		(1·086)	1·146	(1·116)	——	1·121	——
1926	1·166	(1·062)			——	1·069	——
1927[1]		(0·992)		——	——	1·013	——
1928		(0·994)	1·096	——	——	1·001	0·969
1929		(0·961)		(0·971)	——	0·936	——
1930		(0·963)		——	——	0·945	——
1931	——	(0·930)		(0·862)	——	0·900	0·865
1932	——	(0·899)	——	——	——	——	
1933	(1·04)	(0·845)	(1·00)	(0·80)	——	(0·83)	(0·80)

[1] 1926–1927.

RATES, 1871–1933.

Bulgaria	Finland	Hungary	Ukraine	Canada	Australia	New Zealand	Years
—	2·388	—	—	—	—	—	1871–1875
—	2·420	—	—	—	—	—	1876
—		—	—	—	—	—	1877
—		—	—	—	—	—	1878–1880
—	2·363	—	—	—	—	—	1881–1884
—		—	—	—	—	—	1885
—	2·400	—	—	—	—	—	1886–1888
—		—	—	—	—	—	1889–1890
—	2·278	—	—	—	—	—	1891
—		—	—	—	—	—	1892
—		—	—	—	—	—	1893–1894
—		—	—	—	—	—	1895
—		—	(3·65)	—	—	—	1896–1897
—		—	—	—	—	—	1898
—		—	—	—	—	—	1899
—		—	—	—	—	—	1900
3·176	2·140	2·605	—	—	—	—	1901
			—	—	—	—	1902–1903
		2·477	—	—	—	—	1904–1905
3·155			—	—	—	—	1906–1907
			—	—	1·677	—	1908–1909
—	1·716	2·396	—	—		—	1910
—			—	—		1·541	1911
—			—	—			1912
—			—	—			1913
—		—	—	—	—		1914–1915
—		—	—	—	—	1·445	1916–1919
		1·829					1920
2·502	1·402	—	—	—	1·517	1·442	1921
		—	—	—			1922
		—	—	—	—	1·301	1923
		—	—	—	—		1924
		—	—	—	—		1925
2·217[1]		—	2·485	1·649	—		1926
—		—	—	—	—		1927
—		—	—	—	—		1928
—		—	—	—	—		1929
—	—	1·338	—	1·555	—	1·179	1930
—	—	—	—	—	—		1931
(1·8)	(1·1)	(1·2)	—	—	1·068	1·077	1932
			—	—		1·053	1933

in France, rate (*b*) was all through the period under consideration higher than rate (*a*).

Table 39 shows also the gross reproduction rates in the same countries, (*c*) computed by multiplying by 30 the ratio of all female births to women between 15 and 45 years. In the case of Sweden, rate (*c*) was lower than rate (*a*) by 0·5 to 8·0 per cent. Rate (*c*) was also lower than rate (*a*) in Finland, and in Denmark with the exception of the last period, while in France rate (*c*) was all the time higher than rate (*a*).

Table 39 shows finally the gross reproduction rates in the same countries, (*d*) computed by multiplying by 25 the ratio of

TABLE 39.—GROSS REPRODUCTION RATES.

Years	(*a*)	(*b*)	(*c*)	(*d*)	$(b) \gtrless (a)$ per cent	$(c) \gtrless (a)$ per cent	$(d) \gtrless (a)$ per cent
			Denmark				
1878–84	2·2197	2·2428	2·1406	2·2375	+1·0	−3·6	+0·8
1885–94	2·1400	2·1810	2·0843	2·1831	+1·9	−2·6	+2·0
1895–00	2·0416	2·0643	1·9695	2·0796	+1·1	−3·5	+1·9
1901–05	1·9542	1·9810	1·8896	2·0045	+1·4	−3·3	+2·5
1906–10	1·8513	1·9223	1·8312	1·9284	+3·8	−1·1	+4·2
1911–15	1·6707	1·7414	1·6584	1·7483	+4·2	−0·7	+4·6
1916–20	1·5231	1·5866	1·5103	1·5872	+4·2	−0·8	+4·2
1921–25	1·3835	1·4479	1·3812	1·4459	+4·7	−0·2	+4·5
1926–30	1·1662	1·2296	1·1781	1·2253	+5·4	+1·0	+5·1
			Finland				
1866–70	2·0837	2·0808	1·9923	2·0878	−0·1	−4·4	+0·2
1871–75	2·3884	2·4132	2·3103	2·4156	+1·0	−3·3	+1·1
1876–80	2·4204	2·4646	2·3448	2·4554	+1·7	−3·1	+1·4
1881–85	2·3629	2·4298	2·3139	2·3736	+2·8	−2·1	+0·5
1886–90	2·4002	2·4013	2·3082	2·4275	+0·0	−3·8	+1·1
1891–00	2·2783	2·2445	2·1549	2·3003	−1·5	−5·4	+1·0
1901–10	2·1405	2·1469	2·0469	2·1687	+0·3	−4·4	+1·3
1911–20	1·7158	1·7226	1·6332	1·7160	+0·4	−4·8	+0·0
1921–30	1·4020	1·4191	1·3586	1·4313	+1·2	−3·1	+2·1
			France				
1892–97	1·4466	1·4941	1·4505	1·4976	+3·3	+0·3	+3·5
1898–03	1·3932	1·4553	1·4081	1·4437	+4·5	+1·1	+3·6
1904–07	1·3105	1·3703	1·3329	1·3569	+4·6	+1·7	+3·5
1908–13	1·2323	1·2869	1·2545	1·2730	+4·4	+1·8	+3·3
1914–19	0·7659	0·7978	0·7752	0·7838	+4·2	+1·2	+2·3
1920–23	1·2332	1·2606	1·2341	1·2595	+2·2	+0·1	+2·1
1925–27	1·1462	1·1870	1·1656	1·1815	+3·6	+1·7	+3·1
1928–31	1·0957	1·1469	1·1273	1·1291	+4·7	+2·9	+3·0

TABLE 39.—GROSS REPRODUCTION RATES—*continued.*

Years	(*a*)	(*b*)	(*c*)	(*d*)	(*b*) ≷ (*a*) per cent	(*c*) ≷ (*a*) per cent	(*d*) ≷ (*a*) per cent
			Sweden				
1776–80	2·2235	2·2238	2·1376	2·2274	+0·0	−3·9	+0·2
1781–85	2·0092	2·0575	1·9715	2·0381	+2·4	−1·9	+1·4
1786–90	2·0048	2·0754	1·9838	2·0257	+3·5	−1·0	+1·0
1791–95	2·1505	2·1989	2·1114	2·1689	+2·3	−1·8	+0·9
1796–00	2·1279	2·1278	2·0599	2·1369	−0·0	−3·2	+0·4
1801–05	2·0661	2·0551	1·9935	2·0670	−0·5	−3·5	+0·0
1806–10	1·9866	1·9774	1·9109	1·9995	−0·5	−3·8	+0·6
1811–15	2·1083	2·1135	2·0326	2·1270	+0·2	−3·6	+0·9
1816–20	2·1494	2·1804	2·0832	2·1581	+1·4	−3·1	+0·4
1821–25	2·3336	2·3908	2·2919	2·3505	+2·5	−1·8	+0·7
1826–30	2·2484	2·2883	2·2026	2·2726	+1·8	−2·0	+1·1
1831–35	2·2312	2·2149	2·1251	2·2350	−0·7	−4·8	+0·2
1836–40	2·1377	2·0530	1·9727	2·1168	−4·0	−7·7	−1·0
1841–45	2·1534	2·0669	1·9821	2·1187	−4·0	−8·0	−1·6
1846–50	2·0515	2·0317	1·9367	2·0331	−1·0	−5·6	−0·9
1851–55	2·0452	2·0871	1·9763	2·0507	+2·0	−3·4	+0·3
1856–60	2·1723	2·2191	2·1040	2·1739	+2·2	−3·1	+0·1
1861–65	2·1951	2·2062	2·1121	2·1834	+0·5	−3·8	−0·5
1866–70	2·0179	1·9928	1·9280	2·0040	−1·2	−4·5	−0·7
1871–75	2·1472	2·0782	2·0208	2·1350	−3·2	−5·9	−0·6
1876–80	2·1634	2·0704	1·9949	2·1382	−4·3	−7·8	−1·2
1881–85	2·0807	2·0096	1·9371	2·0558	−3·4	−6·9	−1·2
1886–90	2·0489	2·0313	1·9550	2·0438	−0·9	−4·6	−0·3
1891–95	1·9675	1·9482	1·8748	1·9847	−1·0	−4·7	+0·9
1896–00	1·9437	1·9068	1·8335	1·9480	−1·9	−5·7	+0·2
1901–05	1·8813	1·8398	1·7324	1·8888	−2·2	−7·9	+0·4
1906–10	1·7986	1·7811	1·7245	1·8284	−1·0	−4·1	+1·7
1911–15	1·5937	1·6134	1·5510	1·6371	+1·2	−2·7	+2·7
1916–20	1·4145	1·4469	1·3784	1·4501	+2·3	−2·5	+2·5
1921–25	1·2390	1·2716	1·2188	1·2751	+2·6	−1·6	+2·9
1926–30	0·9921	1·0274	0·9875	1·0236	+3·6	−0·5	+3·2
			Ukraine				
1926–27	2·4852	2·6355	2·4416	2·7105	+6·0	−1·8	+9·1
			Moscow				
1926–27	1·1671	1·4414	1·3323	1·3333	+23·5	+14·2	+14·2

all female births to women between 20 and 45 years. In the case of Sweden, the difference between rate (*d*) and rate (*a*) oscillates between +3·2 and −1·6 per cent. Rate (*d*) was higher than rate (*a*) in Denmark by 0·8 to 5·1 per cent, in Finland by 0·0 to 2·1 per cent, in France by 2·1 to 3·6 per cent.

Rate (*d*), which is derived from the ratio of births to women between 20 and 45 years, on the whole, comes nearer to the gross reproduction rates than rates (*b*) and (*c*) derived from the ratio of births to women between 15 and 50 or 15 and 45. But there are countries, like France and the Ukraine, where this is not so. Since, moreover, even in countries where the difference between (*d*) and (*a*), as a rule, is not considerable in itself, like in Denmark, the difference has noticeably changed in the course of time, none of those rates is to be considered a safe substitute for the gross reproduction rate.

6. Inadequate Substitutes for Gross Reproduction Rate

The desirability of classifying the births by age of mothers is, of course, acknowledged also in those countries which do not make this distinction, and the International Statistical Institute in 1869 accepted a resolution, "That in each birth registration certificate the age of the mother, and for the legitimate children also that of the father be stated, and that those data be compiled in tables by age, distinguishing the married woman from the unmarried."[1] William Farr, before that Congress, had repeatedly deplored the lack of such information in his annual reports:

> The English schedule is defective, as it does not show the age of the father and mother at the birth of the child . . .[2]
>
> Two grave defects in the registers of the United Kingdom deprive them of much of their utility as pedigrees, and as records of facts for the solution of the great problems of population. Neither the age of mothers at the births of each of their children, nor the order of birth, is recorded ; so that the number of children borne by women at different ages, and in the course of their lives, cannot be ascertained. This defect was supplied in the first schedule of the Scotch Act, but the important parts of the schedule were unfortunately discontinued after 1855. Dr. Stark turned some of the precious results of that year's registration to account . . .[3]

[1] See *Congrès International de Statistique à la Haye, Compte-rendu des travaux de la septième session, seconde partie*, p. 533, The Hague, 1870.

[2] *Fourteenth Annual Report* (1851), p. xiii ; see also *Sixteenth Report* (1853), p. x ; *Twenty-Seventh Report* (1864), pp. xix–xx.

[3] *Thirtieth Report* (1867), p. 222. See for Scotland *First Detailed Annual Report of the Registrar-General of Births, Deaths, and Marriages in Scotland*, p. xix, Edinburgh, 1861, showing the births by age of mothers for the city of Edinburgh in 1855.

At the Hague Congress Farr said : [1]

The proposition submitted to us appears to me very important. Registration of the mother's age is not done in England. I have given it much thought and I believe it to be a very important element. I, therefore, fully indorse the proposition of Mr. von Baumhauer. Up to now Sweden is, I believe, the only country which has published tables of this kind.

But only once more, in 1875, Farr again drew attention to this lack of information in England : [2]

All that is further wanted now in the English Birth Schedule to clear up this vital question conclusively is the entry of the ages of the mother and father at the birth of their children, and the order of the births.*

For the next 30 years the Registrar-General's reports do not reveal any desire for the information required at the Hague Congress. The first report which again referred to this matter was that for 1904 : [3]

As the Birth Registers in this country do not afford information respecting the ages of the mothers, there are no means of ascertaining the fertility of women at the several ages comprised in the child-bearing period 15–45 years.

One year later the Registrar-General seemed inclined to draw the necessary conclusions : [4]

In my last annual report I also pointed out that the existing English registers of births were capable of improvement. The present registers are defective chiefly in this respect, that the official forms contain no column for the entry either of the age of the mother at the birth of her child or of the number of children previously born to her. In these circumstances I am now considering how far it is practicable to extend the registers so as to include these and other details which may in the future facilitate closer investigation into the important question of the fertility of the English population and its relation to infantile mortality.

[1] *Congrès la Haye, seconde partie*, p. 59.
[2] *Supplement to the Thirty-Fifth Annual Report*, p. xi.
* Done in the Registers of our Australian Colonies.
[3] *Sixty-Seventh Report* (1904), p. xxi ; see also *Seventieth Report* (1907), pp. xxvi, xxix ; *Seventy-Sixth Report* (1913), p. xv.
[4] *Sixty-Eighth Report* (1905), p. lxx.

But the Registrar-General was not able to make up his mind. After another year he stated : [1]

> In my last Annual Report, it was stated that the registers in some respects were no doubt capable of improvement. This has not been lost sight of, but I find, on consideration of this important matter, that further evidence is required as to the desirability, or otherwise, of including some of the proposed improvements, before actually embarking on so large a work as the reconstruction of the registers.

One reason why the Registrar-General then hesitated to include the question about the age of mothers in the birth registration schedule, and why this very simple question, contrary to the custom of most other countries and also of the Dominions, is not yet asked in England, probably is that in the course of the last thirty years several devices have been propagated in England which to their authors seemed to furnish more or less acceptable substitutes for the classification of births by age of mothers. We have already discussed one of these substitutes, the Fertility Census of 1911. When the vital statistician of the General Register Office, Stevenson, submitted this project to the Royal Statistical Society in 1910, he stated: [2]

> The new feature of the approaching Census which interests me personally above all others is the proposal, made originally by the Census Committee of this Society, to include in the schedule an inquiry as to duration of marriage and number of children born. Information on these subjects may be obtained either from the Census or from the registers of births or of deaths . . . It is very much to be desired that when the revision of our registration laws is undertaken, due provision will be made for obtaining information of this type along with the registration of births, if not also of deaths.
>
> As there are no registration facts available in this country, the only means by which the desired information may be obtained consists of a census inquiry.

As shown in Chapter III, the census inquiry failed to provide an adequate measurement of fertility. The two other devices were the standardized birth rate, and the derivation of fertility

[1] *Sixty-Ninth Report* (1906), p. lxvii.

[2] Stevenson, T. H. C., " Suggested Lines of Advance in English Vital Statistics," *Journal of the Royal Statistical Society*, vol. lxxiii, year 1910, p. 694.

rates from the census of 1921 and the total births of the same year.

Standardized Birth Rate.—A standardized birth (or death) rate is computed either through the so-called direct method which consists in choosing a standard population and applying to this standard population the actual quinquennial fertility (or mortality) rates of the community for which one wants to correct the crude birth (or death) rate, or through the so-called indirect method which consists in choosing standard fertility (or mortality) rates and applying those rates to the actual population of the community for which one wants to correct the crude birth (or death) rate. Farr's successor, Dr. Ogle, in 1884, had computed standardized death rates for 28 English towns through the indirect method by taking the population of each town with the age and sex distribution shown at the census of 1881, "and applying to it the mean annual death-rate for each sex and each age-period, in England and Wales in 1871–80." [1] At the Vienna Session of the International Statistical Institute in 1891, however, he submitted a "proposal for the establishment and international use of a standard population, with fixed sex and age distribution, in the calculation and comparison of marriage, birth, and death rates." [2] He suggested:

> In order . . . to obtain death-rates fairly comparable with each other, I think it would be highly desirable to select, at any rate for purposes of international statistics, a standard population, of fixed age and sex distribution, and to ask the officials in each country who are charged with the statistics of mortality, to give each year in their reports the death-rate for their country, as it would have been, had the population agreed in its composition with the international standard.
>
> What this standard population should be is not of very great importance. The point of most importance is that some standard should be selected and generally adopted.

This proposal was officially endorsed in the Registrar-General's Report for 1892. He concluded it by referring

[1] *Annual Summary of Births, Deaths, and Causes of Deaths in London, and other Great Towns*, 1883, p. iii, London, 1884.

[2] See *Bulletin de l'institut international de statistique*, Tome VI, Première Livraison, pp. 83–85.

to the lack of comparability of the marriage, birth and death rates of different countries :

> In previous reports it has been pointed out that as the sex and age distribution of the population varies greatly in different countries, and as the rates largely depend on such distribution, the rates in one country cannot safely be compared with the rates in another, without correction for this difference in the constitution of the several populations.
>
> In order to allow of fair comparison, it is most desirable that the several countries should agree upon some " Standard or Life Table population," that is to say, a population with a fixed age and sex distribution, for international use ; so that the birth, marriage, and death rates for each country may be calculated by this standard. I recommend this suggestion to the notice of the respective Governments.[1]

It may seem surprising that this proposal which presupposed the knowledge of the births by age of mothers came from a country where this knowledge was lacking. But, in fact, apart from the title of his proposal, which included marriages and births, Ogle referred only to deaths, and the ensuing reports and discussions in the Statistical Institute likewise visualized almost exclusively the standardization of the death rate.[2] The proposal of computing a standardized birth rate by the direct method thus fell into oblivion.[3]

The first to suggest the indirect method of standardization in treating fertility apparently was the Government Statistician of Victoria, McLean. He chose as a standard the quinquennial fertility rates of married women " for Sweden (in 1891), which is generally accepted as a normal community,"

[1] *Fifty-Fifth Annual Report* (1892), p. xx. See also *Fifty-Sixth Report* (1893), p. xx.

[2] The project of standardizing the death rate through the direct method was approved by Körsöy, Graf, Bertillon, Guillaume, v. Mayr, Sundbärg, Bodio. It was opposed by Rubin, and particularly by Bortkiewicz, who in his brilliant exposure of the fallacies of this method emphasized the inadequacy of the application of marriage and fertility rates of individual countries to an international standard population. (See *Bulletin de l'institut international de statistique*, VI, 1, pp. 2, 81–82 ; VI, 2, p. 305 ; IX, 2, pp. lxix–lxxi ; XI, 1, pp. 171–179 ; XII, 1, pp. 89–99 ; XIV, 1, pp. 145–151 ; XIV, 2, pp. 417–437.)

[3] It has been repeated again, it is true, by Georg v. Mayr at the Brussels Session of the Congress for Hygiene and Demography (*Compte rendu*, vol. 9, 1903, Brussels), but v. Mayr himself in none of his numerous later writings on the subject referred to this suggestion.

and applied those rates to the numbers of married women in Victoria and New South Wales : [1]

The following table shows the number of annual legitimate births per 1,000 married women—(*a*) If the Swedish rates had been maintained in Victoria and New South Wales ; and (*b*) the actual births in these States :—

Census Year	Victoria		New South Wales	
	(*a*)	(*b*)	(*a*)	(*b*)
1871	303·6	302·7	321·9	331·5
1881	303·1	302·7	318·4	336·3
1891	319·8	297·0	319·5	288·7
1901	291·2	229·0	303·2	235·3

It will thus be seen that the rates prevailing in 1871 and 1881, both in Victoria and New South Wales, were well up to the Swedish standard, but since the latter year there has been a decline in the rate estimated per 1,000 married women, even when due allowance has been made for variations in the age constitutions—in 1891, the decline being equal to about 7 per cent in Victoria, and nearly 10 per cent in New South Wales ; and in 1901, about 21 per cent in Victoria, and 23 per cent in New South Wales. This statement shows the true decline for the two periods, and I shall now proceed to explain the causes which have operated to bring it about. Before doing so, however, I may state that from the English Census material which has recently come to hand, I find that the annual legitimate births per 1,000 married women under 45 years of age are 235. By applying the Swedish rates to the quinquennial groups similarly as in Victoria and New South Wales, the number should have been 299. These results are almost in accord with those of the Australian States, and tend to corroborate the view that the conditions here are now nearly those of a normal community.

McLean's procedure is open to the following objection :

The choice of the Swedish rates as a standard for measuring Australian fertility is most arbitrary. If " the rates prevailing in 1871 and 1881, both in Victoria and New South Wales, were well up to the Swedish standard," there was no point in

[1] McLean, W., " The Declining Birth-Rate in Australia," *Intercolonial Medical Journal of Australasia for* 1904, pp. 112–113.

choosing as a standard the 1891 rates of Sweden instead of the 1871 or 1881 rates of New South Wales. If the conditions in Australia in 1901 were nearly those of a normal community, McLean might just as well have chosen as a standard the 1901 rates of New South Wales. But if he had followed the latter course he would have obtained quite different results.

It appears from Table 40 that the decrease of legitimate

TABLE 40.—FERTILITY OF NEW SOUTH WALES, 1881 AND 1901.

Years of Age	Married Women		Fertility Rates[3]		Computed Births			
					Standard : Sweden		Standard : N.S.W.	
	1881[1]	1901[2]	Sweden 1891	N.S.W. 1901	1881	1901	1881	1901
15–19	2,133	2,564	518	563	1,105	1,328	1,201	1,444
20–24	14,990	19,662	451	397	6,760	8,868	5,951	7,806
25–29	18,667	32,618	375	299	7,000	12,232	5,581	9,753
30–34	17,590	34,608	312	227	5,488	10,798	3,993	7,856
35–39	16,142	33,108	250	173	4,035	8,277	2,793	5,728
40–44	12,654	26,900	142	88	1,797	3,820	1,114	2,367
Total	82,176	149,460	—	—	26,185 = 318·6	45,323 = 303·2	20,633 = 251·1	34,954 = 233·9

fertility in New South Wales, 1881–1901, due to changes in age composition, if measured by the 1891 Swedish rates as a standard, is

$$1-\frac{303\cdot2}{318\cdot6}=4\cdot83 \text{ per cent,}$$

while if measured by the 1901 New South Wales rates as a standard, it is

$$1-\frac{233\cdot9}{251\cdot1}=6\cdot86 \text{ per cent}^4$$

It is evident that the decrease shown in columns (*a*) of McLean's table, which is meant to indicate how much of the

[1] See *New South Wales, Census of* 1881, p. lxii.

[2] See *Results of a Census of New South Wales taken for the Night of 31st March*, 1901, p. 357.

[3] See McLean, p. 112.

[4] It may be mentioned incidentally that in using the Swedish rates for measuring the changes in legitimate fertility in New South Wales, 1881–1891, due to changes in age composition, there appears a slight increase of fertility, while in using the New South Wales rates there appears a slight decrease.

decrease in columns (*b*) is due to a change in age composition, depends largely on the choice of the standard rates and would vary with different standards.

McLean had contented himself with contrasting the actual general legitimate fertility rates of Victoria and New South Wales in 1871–1901 and those which would have obtained if the Swedish quinquennial fertility rates had been in force in those two countries during the entire period under consideration. Newsholme and Stevenson, in the following year, undertook to use McLean's standardized fertility rate for the computation of standardized birth rates. Their trend of thought appears best from the Summary concluding their paper: [1]

1. The ordinary method of calculating the birth-rate does not distinguish between the influence of fertility and of variations in conditions of the population as to age and marriage.

2. In ascertaining the true meaning of the great reduction of the birth-rate which has occurred in the last 25 years, it is necessary to have means for distinguishing between the accidental and the intrinsic causes of change.

3. A step in the right direction is made when the legitimate births are stated in terms of the married women at child-bearing ages, and the illegitimate births in terms of the unmarried women of the same ages.

4. This method fails to correct for the differences of fertility of the various ages comprised in the age-period 15–45.

5. By calculating standard fertility-rates for given populations, McLean overcame the above difficulty, and was thus able to compare experiences of a given community at different times with the standard.

6. In this paper it is shown that by continuing the above process and obtaining corrected fertility-rates, the fertility-rates of different communities can be made directly comparable.

7. The inconveniences of this new and unfamiliar method, and the necessity involved in it of calculating the crude as well as the corrected fertility-rate in every instance, indicate the desirability of obtaining a factor for each community which throughout an entire intercensal period can be applied to the crude birth-rate of that community.

8. The desirability of such a factor is increased by the fact that

[1] Newsholme, Arthur, and Stevenson, T. H. C., "An Improved Method of Calculating Birth-Rates," *The Journal of Hygiene*, vol. v, 1905, pp. 183–184.

the method of corrected fertility-rates does not take into account the proportion of married women in each population.

9. In this paper a method is described of obtaining factors, which, when applied to the readily available crude birth-rates, correct completely both for the varying proportion of married women in compared populations and for the varying fertility at different periods of married life.

(1) Their starting point was the quinquennial fertility rates for Sweden (1891), which they took from McLean, and which they applied to the English census figures according to "a method which is analogous to that employed by the Registrar-General in his Annual Summaries in obtaining factors of correction by means of which corrected death-rates are calculated."

The first portion of this method is shown in the following example:

BERKSHIRE, 1901

Wives aged	No. of Wives	Fertility-rate per 100 Wives at each age-period Sweden	Calculated No. of Births
15–20	139	51·8	72·002
20–25	2,671	45·1	1,204·621
25–30	6,074	37·5	2,277·750
30–35	7,305	31·2	2,279·160
35–40	7,063	25·0	1,765·750
40–45	6,407	14·2	909·794
	29,659		8,509·077

$$\text{Standard fertility-rate} = \frac{\text{Calculated births} \times 1{,}000}{\text{No. of wives aged 15–45}} = \frac{8{,}509{,}077}{29{,}659} = 286{\cdot}9.$$

Standard fertility-rate of England and Wales (1901) similarly calculated = 298·55.

$$\text{Factor of correction} = \frac{\text{Standard rate of England and Wales}}{\text{Standard rate of Berkshire}} = \frac{298{\cdot}55}{286{\cdot}9} = 1{\cdot}0406.$$

The standard fertility-rates for Berkshire and England given above give the total fertility of the wives of child-bearing ages in these two communities, on the supposition that the fertility-rates of these two populations were the same at each age-period as obtained in Sweden in 1891, the Swedish population representing a fairly

normal population. The standard fertility-rate does not therefore represent any fact, but merely serves as a measure of the favourable or unfavourable constitution of the population of a given community for furnishing a high fertility-rate. If a large proportion of the wives are young, the standard rate is high ; if only a comparatively small proportion, it is low. In the above example, the wives of Berkshire were somewhat less favourably aged for child-bearing than those of England and Wales as a whole. The Berkshire recorded fertility-rate (*i.e.* the number of legitimate births per 1,000 wives aged 15–45) must accordingly be increased in proportion to the difference between the two standard rates, in order to render Berkshire comparable with England and Wales.

As the standard fertility-rate is merely used as a measure of favourable or unfavourable age distribution, and as the same measure is applied to all the populations compared, any convenient fertility-rates may be employed, so long as they correctly represent the differences in fertility between the various age-periods. If in the above example the Swedish rates used were increased or decreased in any given proportion the resulting factor of correction would be unchanged, so long as the relation between the different rates remained unaltered.[1]

The authors thus realized that the 1891 Swedish or any other fertility rates offer a gauge for the measurement of the fertility in England only " so long as they correctly represent the differences in fertility between the various age-periods." But they assumed that this was so, *i.e.* that the differences between the quinquennial fertility rates in England (1901) were the same as the differences in Sweden (1891), and this assumption was erroneous. The table on page 140 supplements Newsholme and Stevenson's table for Berkshire by showing the " calculated number of births " for England if the 1891 fertility rates of Sweden are applied, and the " calculated number of births " for Berkshire and for England if the 1901 fertility rates of New South Wales are applied.

It appears that if the fertility rates of New South Wales are used as a standard, the " factor of correction " is 1·0555 as against 1·0406 if the Swedish rates are used. The difference is not great, but by no means negligible, and it was rather a mistake that Newsholme and Stevenson took the Swedish rates instead of the New South Wales rates from McLean's article, since the New South Wales rates probably reflected

[1] *Ibid.*, pp. 178–179.

conditions in England more accurately. As will be seen from our table, the application of the Swedish rates to the English census figures leads to a " calculated number of births " of 1,135,687, while the application of the New South Wales rates yields 866,188. The actual number of legitimate births

Wives aged	No. of Wives	Calculated No. of Births		
		Standard : Sweden	Standard : New South Wales	
	England	England	Berkshire	England
15–20	25,392	13,153·1	78·3	14,295·7
20–25	447,885	201,996·1	1,060·4	177,810·4
25–30	867,718	325,394·3	1,816·1	259,447·6
30–35	913,304	284,950·9	1,658·2	207,320·0
35–40	834,657	208,664·2	1,221·9	144,395·7
40–45	714,986	101,528·0	563·8	62,918·8
	3,803,942	1,135,686·6	6,398·7	866,188·2

$$\text{Standard fertility rate of Berkshire} = \frac{6{,}398{\cdot}7 \times 1{,}000}{29{,}659} = 215{\cdot}74.$$

$$\text{Standard fertility rate of England} = \frac{866{,}188{\cdot}2 \times 1{,}000}{3{,}803{,}942} = 227{\cdot}71.$$

$$\text{Factor of correction} \quad . \quad . \quad . \quad . = \frac{227{\cdot}71}{215{\cdot}74} = 1{\cdot}0555.$$

in England in 1901 was 893,608. The recorded legitimate fertility rate was 235 ; the " standard fertility rate " derived from the New South Wales rates was 228 ; but the " standard fertility rate " derived from the Swedish rates was 299. Fertility in Sweden, 1891, was obviously too high as to provide an adequate standard for measuring differential fertility in England, 1901.

(2) The next step in Newsholme and Stevenson's analysis is to point out an essential difference which they think exists between McLean's and their own standard fertility rates :

> McLean, in the already mentioned paper, employed standard fertility-rates calculated as shown above ; and his comparisons are therefore restricted to comparisons of the same community at different times, and can only be applied very indirectly to the task of comparing different communities

By calculating corrected fertility-rates different communities can be made directly comparable. Thus, in the example of Berkshire, 1901, taken before,

Calculated number of births (as before) = 8,509·077.

Factor of correction = 1·0406.

Recorded fertility-rate $= \frac{\text{births} \times 1{,}000}{\text{wives aged } 15\text{–}45}$ in Berkshire in 1902 = 219·7.

Corrected fertility-rate = 219·7 × 1·0406 = 228·6.[1]

McLean had shown that if the 1891 quinquennial fertility rates of Sweden had prevailed both in Victoria and New South Wales in 1871 and 1901, the number of legitimate births per 1,000 married women between 15 and 45 years would have been in the two colonies in 1871: 303·6 and 321·9; in 1901: 291·2 and 303·2. Newsholme and Stevenson show that if the 1891 quinquennial fertility rates of Sweden had prevailed all over England and Wales in 1901 the number of legitimate births per 1,000 married women between 15 and 45 years would have been 298·55 in England and 286·9 in Berkshire. If, then, the Swedish rates are accepted as an adequate standard, McLean's fertility rates for Victoria and New South Wales offered the opportunity of comparing the fertility of different communities at the same or different times, while Newsholme and Stevenson's fertility rates for England and Berkshire, etc., offered merely the opportunity of comparing the fertility rates of different communities at the same time. They were, therefore, mistaken in stating that their rates could be made directly comparable for different communities, while McLean's comparisons are "restricted to comparisons of the same community at different times and can only be applied very indirectly to the task of comparing different communities." Newsholme and Stevenson make the 1901 general legitimate fertility rate of Berkshire (219·7 births per 1,000 married women) "strictly comparable" with that of England or other communities by multiplying this rate by $\frac{298{\cdot}55}{286}$. It would not have been a more complicated task to make the 1901

[1] Newsholme and Stevenson, p. 180. If they had used the New South Wales rates their corrected fertility rate for Berkshire, 1902, would have been 219·7 × 1·0555 = 231·9.

general legitimate fertility rate of Victoria (229·0) "strictly comparable" with that of New South Wales or other communities by multiplying this rate by $\frac{303{\cdot}2}{291{\cdot}2}$.

(3) The authors finally proceed from "corrected fertility rates" to "standard birth rates."

Such corrected fertility-rates for different communities are strictly comparable. There are, however, several objections to them. The method of statement is unfamiliar. It is necessary to refer to the census figures relating to wives aged 15–45 for each population before the fertility-rate can be calculated, whereas the total population for each community is accessible without reference to census returns. The most important objection is that the fertility of the population as a whole depends not merely upon the ages of its married women, but also upon their number. For these reasons it is desirable to obtain a corrected birth-rate which gives the corrected number of legitimate births in terms of the entire population, and which will thus be similar to, though more accurate than, the familiar crude birth-rate. Such a birth-rate, if truly corrected, will include compensation for, 1st, the ages, and, 2nd, the number of the wives capable of child-bearing. This compensation could be effected in the example of Berkshire taken before by (1) multiplying its crude birth-rate by the factor 1·0406, which would compensate for the higher average age of the Berkshire wives; and then (2) multiplying this result by another factor $\frac{116{\cdot}9}{104{\cdot}6}$ to remove the handicap due to its containing only 104·6 wives aged 15–45 per 1,000 of its population, as compared with 116·9 in England and Wales.

The same result is obtained more easily in one stage by the following method, in which standard birth-rates instead of standard fertility-rates are calculated:

BERKSHIRE, 1901

Calculated no. of births (as before) = 8,509·077.

Total population at census = 283,531.

Standard birth-rate $= \frac{8{,}509{\cdot}077 \times 1000}{283{,}531} = 30{\cdot}01.$

Similarly standard birth-rate of England and Wales = 34·91.

Factor of correction $= \frac{34{\cdot}91}{30{\cdot}01} = 1{\cdot}1633.$

Recorded legitimate birth-rate of Berkshire in 1902 = 22·78.

Corrected " " " " = 26·50.

The standard birth-rates take into account both the ages and the relative number of the wives, and the resulting factor therefore corrects for both.[1]

Newsholme and Stevenson themselves raise three objections to their corrected fertility rates :

(*a*) " The statement of the number of legitimate births per 1,000 of the number of married women aged 15 to 45 . . . has been seldom employed." [2] This " method of statement is unfamiliar." But Newsholme and Stevenson were here mistaken. The statement of the number of legitimate births per 1,000 of the number of married women at child-bearing age was at the time they wrote the most common method of measuring legitimate fertility, and was universally employed as such.[3]

(*b*) " It is necessary to refer to the census figures relating to wives aged 15–45 for each population before the fertility-rate can be calculated, whereas the total population for each community is accessible without reference to census returns." But the " standard birth rate " which they propose as a substitute likewise necessitates the calculation of the births on the basis of the age composition of the wives between 15 and 45 years.

(*c*) " The fertility of the population as a whole depends not merely upon the ages of its married women, but also upon their

[1] Newsholme and Stevenson, pp. 180–181. If the New South Wales rates had been applied instead of the Swedish rates the results would have been as follows :

Standard birth rate of Berkshire	22·57
" " " England and Wales	26·63
Factor of correction	1·180
Recorded legitimate birth rate of Berkshire in 1902	22·78
Corrected " " " "	26·88

The excess of the " standard birth rate " for England over that of Berkshire, and consequently also the excess of the " corrected legitimate birth rate " of Berkshire over its recorded legitimate birth rate, therefore, is 18·0 per cent, if the New South Wales rates are applied and 16·3 per cent if the Swedish rates are applied.

[2] *Ibid.*, p. 176.

[3] See, for instance, Raseri, Enrico, " Les naissances en rapport avec l'âge des parents," *Bulletin de l'institut international de statistique* (1897), X, 2, p. 95 : " La natalité légitime d'une population est d'ordinaire calculée par les démographes, en rapportant le chiffre des nés légitimes à 1,000 femmes mariées aptes, par leur âge, à la fécondation."

number." They, then, take account of the number of married women by relating to the *total* population the number of *legitimate* births, which would have obtained, for instance, in Berkshire, 1901, if the 1891 quinquennial fertility rates for Sweden had prevailed. This ratio they call the " standard birth rate " for Berkshire, and compare it with a similarly computed " standard birth rate " for England and other communities. They finally divide the " standard birth rate " of England and Wales by the standard birth rate of Berkshire, call the quotient the " factor of correction," and multiply the recorded legitimate birth rate of Berkshire, *i.e.* the number of legitimate births per 1,000 inhabitants, by the " factor of correction " in order to find the " corrected legitimate birth rate " of Berkshire.

But what do their "standard birth rates " and their " corrected legitimate birth rate " mean ? The " standard birth rate " for Berkshire means that if the 1891 quinquennial legitimate fertility rates of Sweden had obtained in Berkshire, 1901, there would have been 30·01 legitimate births per 1,000 inhabitants in Berkshire. The " standard birth rate " for England means that if the 1891 quinquennial legitimate fertility rates of Sweden had prevailed in England in 1901, there would have been 34·91 legitimate births per 1,000 inhabitants, *i.e.* 16·33 per cent more than in Berkshire.

The " corrected legitimate birth rate " of England is by definition identical with her crude legitimate birth rate. The " corrected legitimate birth rate " of Berkshire means that in order to make the actual legitimate birth rate of Berkshire comparable with that of England it should be raised by as much as the legitimate birth rate of England would have exceeded the legitimate birth rate of Berkshire, provided that the 1891 quinquennial legitimate fertility rates for Sweden had prevailed in both communities.

The choice of the term " standard birth rate " was certainly misleading since, contrary to the crude birth rate, the " standard birth rate " did not take into account the illegitimate births. The substitution of the legitimate birth rate for the legitimate fertility rate was a mistake, not only because the ratio of

legitimate births to the total population is an "unfamiliar" statement, but also because it is much less instructive.

Newsholme and Stevenson claim that their "corrected fertility rates for different communities are strictly comparable." Their comparability is not actually greater than that of the crude fertility rates which they are meant to replace. Since the "standard birth rates" and the "corrected legitimate birth rates" are computed by using the ratio of the "corrected" to the crude fertility rates, their comparability is likewise inadequate.

In a paper read in December, 1905, to the Royal Statistical Society, Newsholme and Stevenson enlarged their scheme by including also the illegitimate births. But, apart from this correction, they followed exactly the same method as in their former article.[1] When Stevenson succeeded Ogle as vital statistician of the General Register Office, he introduced the same method in the official English statistics.[2] But we are not aware that this method has been used anywhere else,

[1] See "The Decline of Human Fertility in the United Kingdom and Other Countries as shown by Corrected Birth-Rates," *Journal of the Royal Statistical Society*, vol. lxix, year 1906, pp. 34–87. The discussion of their paper, and a paper by Yule, was opened by the Government Statistician of New South Wales, Coghlan, who at that time was rightly considered the greatest British authority on fertility statistics. Coghlan said "he had been a somewhat voluminous writer on this question, and in Australia it was possible to write with some confidence on all branches of vital statistics, as they had had the good fortune of having proper registration offices, from the records of which much information could be gleaned. One thing which these papers brought out above all others, was the absolute necessity of doing something to improve the English vital statistics. It seemed very curious that the Royal Statistical Society, which was known all over the world for the good work it had done and was doing, should have so little influence in improving the census in England and the registration of births, deaths and marriages. The defects of the papers they had heard read chiefly arose from the defects of the British registration returns. . . ." (See *ibid.*, p. 133.) "Dr. Newsholme, in replying for Dr. Stevenson and himself, first referred to Mr. Coghlan's detailed criticism. He could not agree with his disparagement of the official English vital statistics. Any incompleteness in them was owing to want of funds, and as far as the data went they were extremely complete and accurate." (See *ibid.*, p. 144.) But Coghlan had not discussed the reasons for the deficiencies of the English vital statistics (such as the lack of information on mother's age at birth) and had not denied that the data as far as they went were complete and accurate.

[2] See *Supplement to the Seventy-Fifth Annual Report*, Part III, pp. xviii–xxiv, London, 1919.

and it was abandoned also by the General Register Office after the Census of 1921.

Derivation of Fertility Rates from the Census of 1921.—The Registrar-General's report for 1922 contains a table [1] "in which an attempt, for the first time in the course of these official reports, has been made to classify the births, according to the mother's age and thereby gain some evidence of the varying intensity of fertility at different age periods of the mother." [2]

TABLE 41.—FERTILITY RATES BY AGE OF MOTHER, ENGLAND, 1921.

Age Last Birthday	Legitimate Births per 1,000 Married Women	Illegitimate Births per 1,000 Spinsters and Widows
15–	447	7·65
20–	359	15·14
25–	268	8·71
30–	197	0·78
35–	131	—
40–45	32	—

The Registrar-General states :

The classification is not a direct one, that is to say the information relating to the several births has not been obtained from what might be expected to be the natural source of such information, the birth register itself ; the system of birth registration in this country, which has been retained in its present form from the date of its inception, nearly 90 years ago, is quite inadequate for the purpose ; beyond the bare identification of the mother in the birth record, no particulars are available as to her age, the date of her marriage, the number of existing children, and other information all of which is essential for an accurate and continuous examination of the changes in fertility from time to time.

In respect of legitimate children and therefore legitimate fertility, however, it has been found possible to make use of some of the material provided by the 1921 Census. One of the questions on the Census schedule asked, in respect of each married man, the number and ages of all his living children and step-children under the age of 16, and where the man was enumerated on the same schedule as his wife, which was the case with about 93 per cent of the husbands,

[1] Table LXXIV, reproduced here as Table 41.

[2] See *The Registrar-General's Statistical Review of England and Wales for the Year* 1922, Text, p. 137.

the replies enabled children of all ages under 16 to be related to their mother, the latter being also fully described on the schedule. From the information so obtained the ratio

$$\frac{\text{Number of children under 1 year of age}}{\text{Total number of married women}}$$

was formed for various ages of wives, and this, in view of the fact that children less than a year old represent survivors of the births which occurred in the 12 months immediately preceding the date of the Census, has been adopted as the basis of the fertility curve in respect of married women at ages one-half year less than at date of enumeration. The ratios were modified by a constant factor, so that when multiplied by the total married women enumerated at the several ages, the products should aggregate to the number of legitimate births registered in the calendar year 1921; the final ratios are shown in Table LXXIV, and the most cursory glance at the figures reveals the enormous difference in the incidence of fertility at the extreme ages there shown. Below age 20 the chance of a married woman having a child within a year is shown to be nearly $\frac{1}{2}$, between ages 25 and 29 the chance has diminished by 50 per cent to approximately $\frac{1}{4}$, ten years later it is little more than one-eighth, while in the oldest group shown, viz. 40–45, it is but 3 per cent, or about one-fourteenth of that shown for the youngest age group. When a change in the proportion of married women in one group may thus have an effect upon ensuing fertility fourteen times as great as an identical change in another group, the importance of age distribution of the potential mothers is at once manifest, and it must clearly be taken into consideration in a comparative analysis extending over several decades.

Similar fertility curves are not available for earlier census years, but an integral comparison with 1921 is shown in Table LXXV for each Census year back to 1871, and is contrasted in that table with the more familiar and more approximate comparisons given by the cruder birth-rates, whether calculated per 1,000 total population or per 1,000 married women between ages 15 and 45. The new comparisons have been obtained by multiplying the fertility rates at ages in Table LXXIV by the numbers of married women exposed to risk at these ages at the several censuses, thereby providing an "expected" or standard number of births—the number which would have occurred had the 1921 fertility rates been operating—and with the numbers so obtained are compared the actual numbers registered. Thus, in 1871, 1,504 legitimate births were recorded for every 1,000 that would have occurred under existing fertility rates, the present rates being in the aggregate only two-thirds of what they were 50 years ago. From that time the rates diminished

steadily and progressively as shown by the comparative figures, which are 1,481, 1,382, 1,250, and 1,102 at successive ten-year intervals between 1881 and 1911. A noteworthy and somewhat unexpected feature brought out in Table LXXV is that both for the legitimate and illegitimate birth comparisons, the crude birth-rates based upon the total population have in the period under review provided a better index to the changes in fertility than what has always been assumed to be a better method of comparison, that which relates the births to the married or single women of child-bearing ages alone. The effect of the changes in the proportion of these women in the total population has been partially neutralized by their increase in age and the elimination of one of the variables only has worsened rather than improved the comparisons.

A reservation should, perhaps, be added in regard to the basic fertility rates derived from the Census data. As stated above, the children enumerated as belonging to the several classes of married women included step-children and possibly adopted children, and these in the present analysis will have been related to married women of a possibly different age constitution from that of their own natural mothers. Again, the children under one year of age at the date of the Census will have been on average about six months old, and will accordingly only represent that portion of the births of the preceding year which survived the comparatively high mortality operating in the first months of life, while further the married women for whom the facts were forthcoming represent only a sample, though a very large one, of the total married women of the several ages in the whole population. Altogether, it is believed that these defects are not important, and that the final modification of the rates by means of the constant factor referred to succeeds in providing a substantially accurate picture of the 1921 incidence of fertility among married women.[1]

It will have been observed from Tables LXXIV and LXXV that . . . an attempt has been made to allow for the age incidence of the potential mothers in respect of illegitimate as well as legitimate births. The age factors adopted and shown in Table LXXIV have, however, no foundation in either the Census or Registration Records available in this department. At the Census the question of illegitimacy was, on grounds of public policy, carefully avoided both in the printed schedules and in all personal communication with those responsible for filling them up, and as regards birth registration while the fact of illegitimacy is known, the age of the mother remains, in common with all birth registrations in this country, unrecorded and unknown. The rates adopted have, therefore, in the absence of any better authority, been based on those used by the Government

[1] *Ibid.*, pp. 137–140.

TABLE LXXV.—ENGLAND AND WALES—BIRTH RATES AND FERTILITY, 1871–1922.

	1871 (1870–1872)	1881 (1880–1882)	1891 (1890–1892)	1901 (1900–1902)	1911 (1910–1912)	1921 (year 1921 only)	1922
Legitimate Births.							
Births per 1,000 total population . { No.	33·3	32·3	29·4	27·5	23·4	21·4	19·5
{ *Ratio to 1921*	*1,556*	*1,509*	*1,374*	*1,285*	*1,093*	*1,000*	*911*
Births per 1,000 married women, 15–45 { No.	292·5	286·0	263·8	235·5	197·4	176·3	—
{ *Ratio to 1921*	*1,659*	*1,622*	*1,496*	*1,336*	*1,120*	*1,000*	—
Ratio of actual births to those which would have occurred had the 1921 age rates (Table LXXIV) been operating	*1,504*	*1,481*	*1,382*	*1,250*	*1,102*	*1,000*	—
Illegitimate Births.							
Births per 1,000 total population . { No.	1·96	1·65	1·31	1·12	1·03	1·02	0·89
{ *Ratio to 1921*	*1,922*	*1,618*	*1,284*	*1,098*	*1,010*	*1,000*	*873*
Births per 1,000 unmarried women, 15–45 { No.	17·0	14·1	10·5	8·5	7·9	7·9	—
{ *Ratio to 1921*	*2,152*	*1,785*	*1,329*	*1,076*	*1,000*	*1,000*	—
Ratio of actual births to those which would have occurred had the 1921 age rates (Table LXXIV) been operating	*2,051*	*1,688*	*1,247*	*1,008*	*968*	*1,000*	—
All Births.							
Births per 1,000 total population . { No.	35·3	34·0	30·7	28·6	24·4	22·4	20·4
{ *Ratio to 1921*	*1,576*	*1,518*	*1,371*	*1,277*	*1,089*	*1,000*	*911*
Ratio of actual births to those which would have occurred had the 1921 age rates (Table LXXIV) been operating	*1,527*	*1,490*	*1,376*	*1,238*	*1,095*	*1,000*	—

Actuary and the Ministry of Health in the assessment of the maternity risk and benefit to unmarried women for the purpose of National Health Insurance. The rates were adopted on the advice of an influential actuarial committee, and serve in the present connection to complete the tables on the lines followed and already described for married women. The Table LXXIV rates were obtained from the basic rates by constant factor modification so as to produce, when multiplied by the appropriate numbers of single and widowed women, the number of illegitimate births registered in the calendar year 1921, and the comparative figures derived therefrom in Table LXXV may probably be accepted as an improvement upon the crude rate comparisons shown in the same table.[1]

In judging the merits of the fertility rates used in this investigation one must distinguish between the legitimate and the illegitimate fertility rates.

The basic data for the computation of the legitimate fertility rates were given in the Census Report. They read as follows : [2]

Years of Age	Married Women	Children under one year	Children under one year per 1,000 Married Women
15–19	20,089	9,388	467
20–24	347,294	125,746	362
25–29	764,540	201,274	263
30–34	921,248	176,247	191
35–39	960,297	124,462	130
40–44	899,585	55,526	62
45–49	761,418	7,920	10
50–54	558,673	972	2
55–59	374,996	494	1
60–64	241,413	259	1
65–69	161,666	137	1
70 and up	129,624	88	1
Total . . .	6,140,843	702,513	114

The total number of children under one year covered by this table is 702,513, while the total number of children under one enumerated at the Census was 795,474. Taking into consideration that on the one hand a few per cent of the children under one were either omitted or were reported as over one

[1] *Ibid.*, p. 140.

[2] See *Census of England & Wales*, 1921, *Dependency, Orphanhood and Fertility*, p. 241.

year of age and that on the other hand the census figures include the illegitimate children, it may be said that the 702,513 children covered by this investigation comprise nearly 90 per cent of all legitimate children under one living in England on the Census day. So far as completeness is concerned the figures may, therefore, be considered fairly representative for conditions at mid-year 1921.[1] The inclusion of "step-children and possibly adopted children," which is responsible for the large number of married women over 50 years with children under one year, is doubtless a disturbing factor. But it probably does not seriously affect the results for the younger age groups, although it shows what sources of error one has to confront if one attempts to derive fertility from a census instead of data on mothers age at birth secured through birth registration.

The ratios of children under one year to wives were "adopted as the basis of the fertility curve in respect of married women at ages one-half year less than at date of enumeration." A comparison of the rates thus obtained with the rates given in the Census Report shows what would have to be expected for years 15 to 39: a noticeable increase for the age group 15 to 19, a slight increase for the age group 20 to 24, and a slight reduction for the age groups 25 to 39. But the reduction of the rate of age 40 to 44 from 62 to 32 is most surprising, and in view of the lack of any explanation cannot be accepted as justified. The Registrar-General himself was startled by the small fertility rate he had obtained for this group, and we do not know of any case where the difference of the fertility rates for ages 35 to 39 and 40 to 44 is nearly as large. One probably would come nearer to the truth by reducing the rates for all age groups from 15 to 39 by about 4 per cent and raising the rates for 40 to 44 from 32 to about 62.[2]

[1] It should, of course, be borne in mind that the age composition of mothers of children under one cannot be considered normal in view of the extraordinarily large number of marriages in the first post-war years.

[2] The rates would then read:

	429	343	257	189	126	62
instead of	447	359	268	197	131	32

It may be mentioned incidentally that the corresponding rates for Sweden, 1921–1925, were:

	602	355	242	178	130	66

While the legitimate fertility rates, apart from that used for age group 40 to 44, possibly come near the truth, the illegitimate fertility rates "adopted on the advice of an influential actuarial committee" are evidently wrong. The 38,618 illegitimate births have been distributed according to the ages of mothers in the following manner:

Years of Age	Unmarried Women	Births	Fertility Rate
15–19	1,744,086	13,343	7·65
20–24	1,243,278	18,825	15·14
25–29	699,304	6,091	8·71
30–34	460,111	359	0·78
35–39	382,626	—	—
40–44	343,012	—	—

It is impossible that the number of illegitimate births to mothers under 20 should have been more than twice as large as the number of illegitimate births to mothers over 25, and it is obvious that the proportion of births to mothers over 30 cannot have been less than 1 per cent of all illegitimate births. Table 42 shows the distribution of illegitimate births by age of

TABLE 42.—ILLEGITIMATE BIRTHS BY AGE OF MOTHERS.
(Per cent.)

Country	Period	Under 20	20 to 24	25 to 29	30 to 34	35 to 39	40 and up
England	1921	*34·6*	*48·7*	*15·8*	*0·9*	—	—
Denmark [1]	1921–1925	26·2	43·6	16·6	7·7	4·2	1·7
France [2]	1921	20·7	35·7	21·0	12·8	7·3	2·5
Saxony [3]	1921–1925	22·2	52·0	15·7	6·2	3·0	0·9
Spain [4]	1922–1925	12·6	38·5	23·6	13·4	8·1	3·8
Sweden [5]	1921–1925	19·9	43·3	19·5	9·2	5·6	2·5

[1] See *Statistisk Tabelvaerk*, Fifth Series, Letter A, No. 17, p. 35*.
[2] See *Statistique du mouvement de la population*, 1920–1924, p. lxix.
[3] Computed from *Zeitschrift des Sächsischen Statistischen Landesamts*, 1931, p. 54.
[4] Computed from *Movimiento de la Población de España*, 1921–1923, pp. 126, 266; *idem*, 1924–1926, pp. 6, 244.
[5] Confinements; computed from *Befolkningsrörelsen Åren* 1924–1925, p. 4.

mothers for various countries. It also shows that for the measurement of fertility the advice of an influential actuarial committee is no adequate substitute for proper birth registration.

Having ascertained the quinquennial fertility rates for 1921, the Registrar-General computes for each census year back to 1871 the "ratio of actual births to those which would have occurred had the 1921 age rates been operating," and contrasts the decline in this ratio with the decline of "the cruder birth rates" calculated by relating the number of births either to the total population or to the number of women between ages 15 and 45. He concludes: "A noteworthy and somewhat unexpected feature . . . is that both for the legitimate and illegitimate birth comparisons, the crude birth-rates based upon the total population have in the period under review provided a better index to the changes in fertility than what has always been assumed to be a better method of comparison, that which relates the births to the married or single women of child-bearing ages alone." He has since published the results of a similar computation in every single year, and has published in every single year literally the same conclusion.

But can the quinquennial fertility rates for 1921—presuming even they were correct for 1921—be used for ascertaining the trend of fertility in England for the last sixty years? This would evidently be the case if the quinquennial fertility rates had been proportionally the same all the time; but in all countries where fertility has decreased it has decreased very little for the youngest age groups and very much for the older age groups. The computation carried out by the Registrar-General for the sixty-year period would also lead to accurate results if the changes in the quinquennial fertility rates would have been such as to outbalance the changes in the proportion of the rates and the simultaneous changes in the age composition of the married and of the unmarried women. This, however, is most unlikely. If, therefore, the decline in legitimate and illegitimate fertility, measured by the ratio of the actual legitimate or illegitimate births to those which would have occurred had the 1921 quinquennial fertility rates been

operating, differs more from the decline measured by the general legitimate and illegitimate fertility rates than from the decline of the crude legitimate and illegitimate birth rates, this should not be taken as a proof that the crude birth rates have provided a better index to the changes in fertility than the general fertility rates, but rather that the new ratio computed by the Registrar-General is a worse index to the changes in fertility than the general fertility rates.

The data given by the Registrar-General in the third section of Table LXXV are of special interest, since they can be contrasted with the gross reproduction rate. The Registrar-General has found for 1870–1872 as " ratio of actual births to those which would have occurred had the 1921 age rates been operating," 1,527 : 1,000. The method through which he arrived at this result is shown in Table 43.

TABLE 43.—BIRTHS 1870–1872 WITH LEGITIMATE AND ILLEGITIMATE FERTILITY RATES, 1921, ENGLAND.

Years of Age	Married Women, 1871 (1)	Leg. Fertility Rates, 1921 (2)	Computed Leg. Births (3)	Unmarried Women, 1871 (4)	Illeg. Fertility Rates, 1921 (5)	Computed Illeg. Births (6)	Computed Total Births (7)
15–19	34,573	447	15,454	1,075,281	7·65	8,226	23,680
20–24	361,317	359	129,713	684,074	15·14	10,357	140,070
25–29	584,733	268	156,708	351,462	8·71	3,061	159,769
30–34	598,343	197	117,874	221,899	0·78	173	118,047
35–39	536,598	131	70,294	179,417	—	—	70,294
40–44	485,204	32	15,527	143,201	—	—	15,527
Total	2,600,768	—	505,570	2,655,334	—	21,817	527,387

If the legitimate and the illegitimate fertility rates of 1921 had been operating in 1870–1872, the average number of births in 1870–1872 would have been 527,387. Since the actual average number of births in 1870–1872 was 805,374, the ratio was 1,527 : 1,000. The ratio of the crude birth rate, 1870–1872, to the crude birth rate, 1921, was 1,576 : 1,000. The Registrar-General does not show the trend of the general fertility rate (total birth rate per 1,000 women 15 to 45). The general fertility rate was 153·2 in 1870–1872 as against 89·6 in 1921. The ratio of the general fertility rate, 1870–1872, to the

general fertility rate, 1921, then, was 1,709 : 1,000. It is not particularly surprising that the drop of the general fertility rate was much larger in those 50 years than the drop of the crude birth rate. It is what one would have expected in view of the increasing proportion of women at child-bearing age. But it is certainly surprising that the new ratio computed by the Registrar-General shows an even smaller drop than the crude birth rate. Can fertility actually have fallen so little as the new ratio indicates ?

TABLE 44.—BIRTHS AND FERTILITY RATES, ENGLAND, 1921.

Years of Age	Married Women	Leg. Fertility Rate	Leg. Births	Unmarried Women	Illeg. Fertility Rate	Illeg. Births	Total Women	Total Births	Fertility Rates
15–19	31,145	447	13,919	1,744,086	7·65	13,343	1,775,231	27,262	15·36
20–24	459,789	359	165,031	1,243,278	15·14	18,825	1,703,067	183,856	107·96
25–29	920,986	268	246,774	699,304	8·71	6,091	1,620,290	252,865	156·09
30–34	1,059,538	197	208,687	460,111	0·78	359	1,519,649	209,046	137·53
35–39	1,089,287	131	142,668	382,626	—	—	1,471,913	142,668	96·92
40–44	1,035,109	32	33,117	343,012	—	—	1,378,121	33,117	24·03
Total	4,595,854	—	810,196	4,872,417	—	38,618	9,468,271	848,814	537·89

The last column of Table 44 shows the fertility rates of all women at child-bearing age derived from the legitimate and illegitimate fertility rates as ascertained by the Registrar-General for 1921. From those rates total fertility appears to have been 2,689, while the gross reproduction rate was 1·311. If those rates had operated in 1870–1872 the number of births would have been 473,341. Since there actually occurred 805,374 births, the ratio of actual births to those which would have occurred had the 1921 rates been prevailing would have been 1,701 : 1,000. Total fertility would have been 4,576, and the gross reproduction rate would have been 2·244 or 1·711 as high as in 1920–1922.

According to the Registrar-General's computation the actual average number of births in 1870–1872 would have been 527,387 if the legitimate and the illegitimate fertility rates of 1921 had been operating. The fertility rates derived from this number of births (by dividing col. (7) by cols. (1)+(4) of Table 43) yield a total fertility of 2,964. The number of 527,387 births, as has been shown, must be multiplied by 1·527 in order to

obtain the actual number of 805,374 births. If total fertility is raised in the same proportion it would appear to be 4,526, while the gross reproduction rate would be 2·220, *i.e.* 1·693 times as high as in 1921.

But it is possible, of course, that fertility rates may have been quite different. If we assume that quinquennial fertility rates like those of Finland, 1871–1875, which show a rather low fertility for the younger age groups and a high fertility for the oldest age groups had been operating in England, 1870–1872, total fertility in England would have been 4,795, and the gross reproduction rate 2·352, *i.e.* 1·793 times as high as in 1921. It would be easy, on the other hand, to construct a scale of fertility rates which actually would lead to a gross reproduction rate for England, 1870–1872, only 1·527 times as high as that for 1921. But we suppose that the student by this time will be convinced that the choice of fertility rates for a period 50 years back is so arbitrary that the results obtained are most unsafe and that there is no justification whatsoever for considering results thus obtained a means of testing results through a less arbitrary method, even if this method like that underlying the general fertility rate is open to objections.

7. Gross Reproduction Rate of Married Women

The gross reproduction rate indicates how many girls are born to a woman passing through child-bearing age. Thus the gross reproduction rate for Denmark, 1926–1930, was 1·165. The number of girls born to 1,000 women passing through child-bearing, according to fertility in Denmark, 1926–1930, therefore, was 1,165. Part of those girls were illegitimately born. In order to ascertain how many of the 1,165 girls were legitimate and how many were illegitimate, it suffices to compute the gross reproduction rate for legitimate and for illegitimate births separately. Table 45 shows in col. (1) the females at child-bearing age by quinquennial age groups; in cols. (2), (3) and (4) the illegitimate, the legitimate, and the total female births by quinquennial age groups; in cols. (5), (6), and (7) the fertility rates computed by relating the

TABLE 45.—FERTILITY RATES BY LEGITIMACY IN DENMARK, 1926–1930.

Years of Age	Female Population (1)	Yearly Female Births			Fertility Rates		
		Illeg. (2)	Leg. (3)	Total (4)	Illeg. (5)	Leg. (6)	Total (7)
15–19	167,000	1,018	811	1,829	6·1	4·9	11·0
20–24	158,400	1,538	6,746	8,284	9·7	42·6	52·3
25–29	148,200	565	9,130	9,695	3·8	61·6	65·4
30–34	135,500	259	6,927	7,186	1·9	51·1	53·0
35–39	120,200	135	4,110	4,245	1·1	34·2	35·3
40–44	111,000	45	1,576	1,621	0·4	14·2	14·6
45–49	99,000	4	135	139	0·0	1·4	1·4
Total .	939,300	3,564	29,435	32,999	23·0	210·0	233·0

legitimate, the illegitimate, and the total female births to the female population at the respective age groups. (Col. (7) is, of course, equal to the sum of cols. (5) and (6).) If the totals for cols. (5), (6), and (7) are multiplied by five, it appears that of the 1,165 girls born to 1,000 women passing through child-bearing age, 1,050 were legitimately born and 115 were illegitimately born.

All legitimately born children are the children of women who are or have been married. Table 46 shows in cols. (1)

TABLE 46.—GROSS REPRODUCTION RATE OF MARRIED AND NOT MARRIED FEMALES IN DENMARK, 1926–1930.

Years of Age	Female Population		Fertility Rates		Years lived by 1,000 females		Girls borne by 1,000 females		
	Single (1)	Married Widowed Divorced (2)	Illeg. (3)	Leg. (4)	in single state (5)	after first wedding (6)	Illeg. (7)	Leg. (8)	Total (9)
15–19	164,150	2,850	6·2	284·6	4,904	96	30·4	27·4	57·8
20–24	113,400	45,000	13·6	149·9	3,562	1,438	48·3	215·5	263·8
25–29	56,750	91,450	10·0	99·8	1,885	3,115	18·8	310·9	329·7
30–34	33,300	102,200	7·8	67·8	1,211	3,789	9·4	256·8	266·2
35–39	23,800	96,400	5·7	42·6	982	4,018	5·6	171·3	176·9
40–44	19,850	91,150	2·3	17·3	884	4,116	2·0	71·2	73·2
45–49	16,100	82,900	0·2	1·6	833	4,167	0·2	6·8	7·0
Total	427,350	511,950	—	—	14,261	20,739	114·7	1,059·9	1,174·6

and (2) the single females and the married, widowed, and divorced females at child-bearing age by quinquennial age groups; in cols. (3) and (4) the ratio of illegitimate female

births to 1,000 single females and the ratio of legitimate female births to 1,000 married, widowed, and divorced females; in cols. (5) and (6) the number of years lived by 1,000 females in single state and after the first wedding according to the nuptiality table;[1] in cols. (7), (8), and (9) the number of illegitimate girls, legitimate girls, and all girls borne by 1,000 females passing through child-bearing age and subject to the nuptiality and the fertility of 1926–1930 (col. (7) being the product of cols. (3) and (5), col. (8) the product of cols. (4) and (6), and col. (9) the sum of cols. (7) and (8)).

While the gross reproduction rate computed in the usual manner, *i.e.* on the basis of fertility as it was in 1926–1930, but without regard to the specific nuptiality of 1926–1930, was 1·165, the gross reproduction rate computed on the basis of fertility and nuptiality of 1926–1930 (col. 9) is 1·175. Of the 1,175 girls borne by 1,000 females passing through child-bearing age, 1,060 are legitimate and 115 are illegitimate children. Since, according to the nuptiality table, 837 out of 1,000 females reaching the age of 50 years had married (while 163 had remained single) the gross reproduction rate of women who married (once or oftener), if measured by legitimate births only, was $\frac{1{\cdot}060}{0{\cdot}837}=1{\cdot}267$.

But a considerable part of the 115 illegitimate girls were borne, either before, or during, or after marriage, by women who had married. The 163 (or exactly 163·44) females who do not marry live 35 years $\times 163{\cdot}44 = 5{,}720$ years in child-bearing age. Since the number of years lived in single state by 1,000 females of child-bearing age is 14,261 (see Table 46, col. 5), the females who married lived 8,541 years in single

[1] A nuptiality table is computed by the same method as a life table of the female population, the only difference being that the number of single females is substituted for the number of all females and the number of first marriages for the number of deaths. The number of years lived in single state at the age of 15 to 16, 16 to 17, etc., years is derived from the number of females remaining single at 15, 16, etc., years in the same manner as the total number of years lived at the age of 15 to 16, 16 to 17, etc., years is derived from the total number of females surviving 15, 16, etc., years. The number of years lived after the first wedding is found by deducting for each quinquennial age group the number of years lived in single state from the total 5,000 years lived by 1,000 females.

state. Assuming that the fertility of single women is the same whether they marry subsequently or not and that the illegitimate children were all born to single females, the proportion of illegitimate girls born to females who married later would be 60 per cent. But part of the illegitimate children are born to married, widowed, or divorced women. Assuming that they constitute 4 per cent of all illegitimate children,[1] the proportion of illegitimate girls born to females in married, widowed, or divorced state would amount to 64 per cent. Of the total 115 illegitimate girls, 73 would then be born to females who married once or more, and 42 to females who never married. The gross reproduction rate of those who married would then be $\frac{1{\cdot}133}{0{\cdot}837}=1{\cdot}355$ as against 1·175 for all women.[2]

[1] See p. 17.

[2] The gross reproduction rate of those who never married would be $\frac{0{\cdot}042}{0{\cdot}163}=0{\cdot}253$. Assuming that the 163 women who remained single had married at the same ages as those who did marry and had displayed exactly the same (illegitimate and legitimate) fertility, they would have borne 12 (instead of 42) illegitimate and 173 legitimate girls, and the gross reproduction rate for all females would have been 1·318 (instead of 1·175). But this assumption evidently leads to an overestimate of the effect of universal marriage upon the reproduction rate, since the proportion of unfecund women probably is larger among those who remain single than among those who do marry.

An approach to universal marriage would thus not have a very strong effect upon fertility in a country like Denmark, and the same is true, for instance, of England. The effect, however, might be very marked in the Free State of Ireland and in Northern Ireland, where the proportion of girls who do not marry is large and where at the same time the number of illegitimate children is small. The effect probably would be less conspicuous (although stronger than in Denmark) in Sweden, where with a low nuptiality the proportion of illegitimate children is very high. It would be negligible in countries like France and Germany, where nuptiality is high and the proportion of illegitimate children also is rather high. In such countries the number of births may increase temporarily if marriages increase, but marriages could not be kept permanently on a much higher level than heretofore, since, anyway, only a very small proportion of girls remained unmarried.

CHAPTER V

MEASUREMENT OF MORTALITY

1. Crude Death Rate

The most common method of measuring mortality consists in relating the number of deaths to the total population. This method of computing a *death rate* has first been used by John Graunt (1662) when, on the basis of some population estimates, he stated " that little more then one of 50 dies in the Country, whereas in London, it seems manifest, that about one in 32 dies, over and above what dies of the Plague." [1] Nowadays the yearly death rate is usually computed by stating the number of deaths per 1,000 of the average population.

What is the range of the death rate ? Theoretically the upper limit is 1,000, but such a rate would mean the extinction of a total population within a year. At the time of the Black Death (1348), the death rate may have reached several hundred in one country or another. In any case, many death rates have been recorded which exceeded the highest recorded birth rate. It may suffice to mention as an example the 1868 death rate of Finland which amounted to 78, and which was due to a famine. In 1932, according to the *Statistical Year-Book of the League of Nations*, the death rate varied between 29 in Egypt and 8 in New Zealand ; but this computation does not include such countries as China, which probably had a higher death rate than Egypt. Table 47 gives a survey of the death rates for various countries.[2]

In Western and Northern Europe, taken as a whole, the death rate (just as the birth rate) was fairly constant from 1841 to 1885. It was 22·5 in 1841–1845 and 22·1 in 1881–1885,

[1] Graunt, *Natural and Political Observations*, 1st ed., p. 69.

[2] For the basic data, *i.e.* the mean population and the number of deaths, see Tables I and VI in the Appendix.

reaching its maximum (24·9) in 1846–1850. In the last 50 years, however, it showed a steady decrease, interrupted only through the World War. By 1911–1914 it had declined to 16·6, rose to 19·6 in 1915-1919, was 14·2 in 1920–1923, 13·2 in 1924–1926, 13·1 in 1927–1930, and 12·6 in 1931–1933.

2. Life Tables

The death rate shows the proportion by which a population decreases through deaths, but it is not an adequate measure of mortality, since it is calculated without regard to the sex and age composition of the population. The factor of sex composition is eliminated by computing a separate death rate for each sex, relating the male deaths to the male population and the female deaths to the female population. The factor of the age composition is eliminated by computing a life table.

The first concept of a life table is to be found in Graunt's *Observations* (1662). Having ascertained that in the 20 years, 1629–1636 and 1647–1658, 229,250 deaths had been registered in London, of which 16,384 were caused by the plague,[1] he estimated that 36 per cent of the 212,866 deaths not due to the plague were deaths of children under six years of age :

> Having premised these general Advertisements, our first Observation upon the *Casualties* shall be, that in twenty Years there dying of all diseases and *Casualties*, 229,250 that 71,124 dyed of the *Thrush*, *Convulsion*, *Rickets*, *Teeth*, and *Worms ;* and as *Abortives*, *Chrysomes*, *Infants*, *Liver-grown*, *and Overlaid ;* that is to say, that about $\frac{1}{3}$ of the whole died of those Diseases, which we guess did all light upon Children under four or five Years old.
>
> There died also of the *Small-Pox*, *Swine-Pox*, and *Measles*, and of *Worms* without *Convulsions*, 12,210 of which number we suppose likewise, that about $\frac{1}{2}$ might be Children under six Years old. Now, if we consider that 16 of the said 229 thousand died of that extraordinary and grand *Casualty* the *Plague*, we shall finde that about thirty-six *per centum* of all quick conceptions, died before six years old.[2]

[1] See Graunt, *Observations*, 1st ed., Table following p. 74.
[2] *Ibid.*, p. 15.

TABLE 47.—YEARLY

1. *Western and Northern*

Years	Belgium	Denmark	England and Wales	Scotland	Northern Ireland	Irish Free State	Ireland (Total)
1841–45	23·4	19·6	21·4	—	—	—	—
1846–50	25·3	21·1	23·3	—	—	—	—
1851–55	22·4	20·3	22·7	20·8 [1]	—	—	—
1856–60	22·2	20·8	21·8	20·7	—	—	—
1861–65	22·7	20·2	22·6	22·1	—	—	16·6
1866–70	23·9	19·6	22·4	22·0	—	—	16·6
1871–75	23·4	19·5	22·0	22·7	—	—	17·7
1876–80	21·8	19·4	20·8	20·6	—	—	18·8
1881–85	20·7	18·4	19·4	19·6	—	—	18·0
1886–90	20·3	18·7	18·9	18·8	—	—	17·9
1891–95	20·3	18·6	18·7	19·0	—	—	18·5
1896–00	18·2	16·4	17·7	17·9	—	—	18·1
1901–05	17·1	14·8	16·0	17·0	—	—	17·6
1906–10	16·0	13·7	14·7	16·1	—	—	17·3
1911–14	15·0	12·9	13·9	15·3	17·5	16·3	16·7
1915–19	15·8	13·1	14·4	15·6	18·4	17·3	17·6
1920	13·9	13·0	12·4	14·0	16·7	14·7	15·3
1921	13.8	11·0	12·1	13·6	15·3	14·4	14·7
1922	14·2	11·9	12·8	14·9	15·6	14·7	15·0
1923	13·2	11·3	11·6	12·9	14·9	14·0	14·3
1924	13·1	11·2	12·2	14·5	16·1	15·0	15·4
1925	13·2	10·8	12·2	13·5	15·7	14·6	15·0
1926	13·4	11·0	11·6	13·1	15·0	14·1	14·3
1927	13·5	11·6	12·3	13·6	14·6	14·8	14·7
1928	13·3	11·0	11·7	13·5	14·4	14·2	14·2
1929	15·1	11·2	13·4	14·7	15·9	14·6	15·0
1930	13·3	10·8	11·4	13·3	13·8	14·2	14·0
1931	13·3	11·4	12·3	13·3	14·4	14·5	14·5
1932	13·2	11·0	12·0	13·5	14·1	14·5	14·4
1933	13·2	10·6	12·3	13·2	14·3	13·5	13·8

See footnote to Tables I and VI, Appendix.

[1] 1855 only.

2. *Other Countries,*

Years	Austria		Bulgaria	Czecho-slovakia	Danzig	Estonia	Finland	Hungary		Italy
	(1)	(2)						(1)	(2)	
1871–75	32·6	31·0	—	—	—	—	21·7	45·7	—	30·5 [1]
1876–80	30·5	28·8	—	—	—	—	22·7	36·6	—	29·4
1881–85	30·2	28·1	—	—	—	—	22·2	32·9	—	27·3
1886–90	28·9	26·8	—	—	—	—	20·0	31·9	—	27·2
1891–95	27·9	25·5	27·8	—	—	—	20·5	31·9	—	25·5
1896–00	25·6	23·3	23·9	—	—	—	19·0	27·9	—	22·9
1901–05	24·3	21·9	22·5	24·4	—	—	18·6	26·4	—	22·0
1906–10	22·4	20·3 [4]	23·8	21·8	—	—	17·4	25·0	—	21·2
1911–14	20·9 [4]	18·8 [4]	22·9	20·4	—	—	16·1	23·8	22·7	19·1
1915–19	—	20·4 [6]	22·9	18·5 [6]	—	—	19·5	25·7 [7]	22·2	25·0
1920	19·0	19·0	21·4	19·0	17·1	—	15·9	21·4	21·4	—
1921	17·0	17·0	21·7	17·7	15·6	—	14·0	21·2	21·2	17·8
1922	17·4	17·4	21·2	17·4	17·1	16·7	14·4	21·4	21·4	18·1
1923	15·3	15·3	21·2	15·0	15·3	15·0	13·8	19·5	19·5	17·0
1924	14·9	14·9	20·7	15·3	14·4	15·2	15·3	20·4	20·4	17·1
1925	14·3	14·3	19·2	15·2	13·0	14·9	13·5	17·1	17·1	17·2
1926	14·9	14·9	17·2	15·6	13·2	16·2	13·4	16·7	16·7	17·2
1927	14·9	14·9	20·3	16·0	13·1	17·3	14·5	17·8	17·8	16·1
1928	14·4	14·4	17·6	15·1	12·5	15·9	13·5	17·2	17·2	16·1
1929	14·5	14·5	18·1	15·5	12·9	18·1	15·0	17·8	17·8	16·5
1930	13·5	13·5	16·1	14·2	12·3	14·9	13·2	15·5	15·5	14·1
1931	14·0	14·0	16·9	14·4	11·9	16·2	13·3	16·6	16·6	14·8
1932	13·9	13·9	16·3	14·1	11·4	14·8	12·6	17·9	17·9	14·7
1933	13·2	13·2	15·4	13·7	11·5	14·7	12·9	14·7	14·7	13·7

See footnote to

[1] 1872–1875 only. [2] 1873–1875 only. [3] 1878–1880 only. [4] 1911–1913 only.

DEATH RATES.

Europe, 1841–1933.

France		Germany		Holland	Norway	Sweden	Switzerland	Total	Years
(1)	(2)	(1)	(2)					(2)	
22·7	22·8	26·2	25·7	23·9	17·4	20·2	—	22·5	1841–45
23·9	24·0	27·6	27·2	28·4	18·8	20·9	—	24·9	1846–50
24·1	24·2	27·2	26·6	24·4	17·3	21·7	—	24·0	1851–55
23·8	23·9	25·7	25·1	26·9	16·9	21·7	—	23·1	1856–60
22·9	22·9	26·0	25·8	24·9	18·5	19·8	—	23·2	1861–65
24·4	24·4	27·8	27·5	25·2	17·4	20·5	25·8 [3]	24·2	1866–70
24·9	25·1	28·2	28·1	25·5	17·5	18·3	23·8	24·5	1871–75
22·5	22·6	26·1	26·0	22·9	16·6	18·3	23·1	22·8	1876–80
22·2	22·3	25·7	25·6	21·4	17·1	17·5	21·3	22·1	1881–85
22·0	22·0	24·4	24·3	20·5	17·1	16·4	20·4	21·4	1886–90
22·3	22·3	23·3	23·2	19·6	16·9	16·6	19·8	21·1	1891–95
20·7	20·7	21·2	21·1	17·2	15·7	16·1	18·1	19·5	1896–00
19·6	19·6	19·9	19·7	16·0	14·6	15·5	17·5	18·2	1901–05
19·2	19·1	17·5	17·4	14·3	13·9	14·3	16·0	16·8	1906–10
20·5	20·4	16·7	16·6	12·9	13·4	13·9	14·5	16·6	1911–14
24·0	24·0	20·3	19·9	14·0	14·4	14·8	14·7	19·6	1915–19
17·2	17·2	15·1	15·1	12·3	12·8	13·3	14·4	14·6	1920
17·7	17·7	13·9	13·9	11·4	11·5	12·4	12·8	14·1	1921
17·5	17·5	14·4	14·4	11·7	12·1	12·8	13·0	14·4	1922
16·7	16·7	13·9	13·9	10·2	11·6	11·4	11·8	13·6	1923
16·9	16·9	12·3	12·2	9·8	11·3	12·0	12·6	13·3	1924
17·4	17·4	11·9	11·9	9·8	11·1	11·7	12·2	13·2	1925
17·4	17·4	11·7	11·7	9·8	10·8	11·8	11·8	13·0	1926
16·5	16·5	12·0	12·0	10·2	11·2	12·7	12·4	13·2	1927
16·4	16·4	11·6	11·6	9·6	10·9	12·0	12·1	12·8	1928
17·9	17·9	12·6	12·6	10·7	11·5	12·2	12·5	14·0	1929
15·6	15·6	11·1	11·0	9·1	10·5	11·7	11·6	12·3	1930
16·2	16·2	11·2	11·2	9·6	10·9	12·5	12·1	12·8	1931
15·8	15·8	10·8	10·8	9·0	10·6	11·6	12·1	12·4	1932
15·8	15·8	11·2	11·2	8·8	10·2	11·2	11·4	12·5	1933

[2] 1864–1865 only. [3] 1870 only.

1871–1933.

Latvia	Lithuania	Poland	Portugal	Rumania	Russia (Europe)	Spain	Yugoslavia	Australia	New Zealand	Years
—	—	—	—	33·2 [2]	37·1	—	33·0	15·7	12·9	1871–75
—	—	—	—	31·5	35·7	30·4 [3]	35·3	15·8	11·8	1876–80
—	—	—	—	26·5	36·5	32·6	24·8	15·7	11·0	1881–85
—	—	—	—	28·9	34·6	30·9	26·2	14·8	9·9	1886–90
—	—	—	—	31·1	36·2	30·2	29·1	13·3	10·1	1891–95
—	—	—	—	27·6	32·1	28·8	25·0	12·7	9·6	1896–00
—	—	—	—	25·7	31·0	25·9	22·5	11·7	9·9	1901–05
—	—	—	—	26·2	29·6	24·0	24·5	10·7	9·7	1906–10
—	—	—	19·8 [5]	24·7	27·2	22·1	—	10·8	9·3	1911–14
—	20·4	26·9 [6]	25·9	24·7 [7]	—	24·3	—	10·8	10·5	1915–19
—	21·2	27·0	23·7	26·7	—	23·2	21·1	10·5	10·2	1920
—	15·2	20·9	20·8	23·8	—	21·3	20·9	9·9	8·7	1921
15·2	17·6	19·9	20·6	23·7	—	20·5	20·8	9·2	8·8	1922
14·3	15·0	17·4	23·0	23·1	—	20·7	20·3	9·9	9·0	1923
15·5	16·2	18·0	20·2	23·4	—	19·7	20·1	9·5	8·3	1924
15·0	16·8	16·8	18·7	21·8	20·1	19·6	18·7	9·2	8·3	1925
14·8	15·3	17·8	20·2	22·1	19·9	18·9	18·8	9·4	8·7	1926
15·4	17·1	17·3	19·2	22·9	20·7	18·8	20·9	9·4	8·4	1927
14·5	15·5	16·4	19·1	20·2	18·1	18·3	20·3	9·4	8·5	1928
15·0	17·0	16·7	18·1	21·4	19·5	18·0	21·1	9·5	8·8	1929
14·2	15·8	15·5	17·6	19·4	—	17·4	19·0	8·6	8·6	1930
14·0	15·7	15·5	17·2	20·8	—	17·5	19·8	8·7	8·3	1931
13·7	15·2	15·0	17·5	21·7	—	16·3	19·2	8·6	8·0	1932
13·6	13·4	14·2	17·6	18·7	—	16·4	—	8·9	8·0	1933

Tables I and VI, Appendix.

[5] 1912–1914 only. [6] 1919 only. [7] 1915 only.

He then proceeds to estimate the number of deaths at the other ages of life :

Whereas we have found, that of 100 quick Conceptions about 36 of them die before they be six years old, and that perhaps but one surviveth 76,[1] we, having seven *Decads* between six and 76, we sought six mean proportional numbers between 64, the remainder, living at six years, and the one, which survives 76, and finde, that the numbers following are practically near enough to the truth ; for men do not die in exact Proportions, nor in Fractions : from whence arises this Table following.

Viz. of 100 there dies within the first six years . . .	36	The fourth	6
The next ten years, or *Decad* .	24	The next	4
The second *Decad*	15	The next	3
The third *Decad*	09	The next	2
		The next	1

From whence it follows, that of the said 100 conceived there remains alive at six years end 64.

At Sixteen years end . . .	40	At Fifty six	6
At Twenty six	25	At Sixty six	3
At Thirty six	16	At Seventy six	1
At Fourty six	10	At Eighty	0

It follows also, that of all, which have been conceived, there are now alive 40 *per Cent.* above sixteen years old, 25 above twenty six years old, *& sic deinceps*, as in the above Table : there are therefore of Aged between 16, and 56, the number of 40, less by six, *viz.* 34 ; of between 26, and 66, the number of 25 less by three, *viz.* 22 : *& sic deinceps.*[2]

Quite apart from the fact that Graunt's assumptions about the number of deaths at various ages were mere guesswork, his argument suffers from two serious defects :

(1) Having estimated that 36 per cent of all deceased were under six years of age, he concludes " that about thirty-six *per centum* of all quick conceptions died before six years old." This would only be true if the number of " quick conceptions " (live-born) had been equal to the number of deaths, and if those exposed to the risk of death in London had been affected only by the number of births and not by migration to and from the city. His whole table of survivors, therefore, is not correct.

[1] He does not give his reasons for this assumption.
[2] Graunt, pp. 61–62.

(1) Having found that 40 per cent survived the age of 16 and 6 per cent the age of 56, he concluded that there are " Aged between 16 and 56 the number of 40, less by six, *viz.* 34." He thus erroneously takes the number of deaths between the two ages for the number of living between those two ages.[1]

Graunt's computations attracted the attention of his friend, Sir William Petty, and of several Dutch mathematicians, in particular the two brothers Huygens. But a real progress was only achieved when, 30 years after the publication of Graunt's *Observations*, the Royal Society in London submitted Caspar Neumann's investigations of the mortality in Breslau, 1687–1691, to Edmund Halley, asking for his opinion. Halley secured from Neumann additional material and thereupon wrote his famous study, " An Estimate of the Degrees of the Mortality of Mankind, drawn from curious Tables of the Births and Funerals at the City of Breslaw." [2] Halley begins by stating that Graunt's (and Petty's) deductions were defective : [3]

> First, in that the *Number* of the People was wanting. Secondly, That the *Ages* of the People dying was not to be had. And Lastly, That both *London* and *Dublin* by reason of the great and casual Accession of *Strangers* who die therein, (as appeared in both, by the great Excess of the *Funerals* above the *Births*) rendered them incapable of being Standards for this purpose ; which requires, if it were possible, that the People we treat of should not at all be changed, but die where they were born, without any Adventitious Increase from Abroad, or Decay by Migration elsewhere.[2]

He considered his material free from the second and third defects : [4]

> This *Defect* seems in a great measure to be satisfied by the late curious Tables of the Bills of *Mortality* at the City of *Breslaw*, lately communicated to this Honourable Society by Mr. *Justell*, wherein both the *Ages* and *Sexes* of all that die are monthly delivered, and

[1] See also Westergaard, Harald, *Contributions to the History of Statistics*, p. 23, London, 1932.

[2] *Philosophical Transactions of the Royal Society*, No. 196, January, 1693, pp. 596–610. See also " Some further Considerations on the Breslaw Bills of Mortality," By the same Hand, *ibid.*, No. 198, March, 1693, pp. 654–656.

[3] *Ibid.*, p. 597.

[4] *Ibid.*, pp. 597–598.

compared with the number of the *Births*, for Five Years last past, *viz.* 1687, 88, 89, 90, 91, seeming to be done with all the Exactness and Sincerety possible.

This City of *Breslaw* . . . is very far from the Sea, and as much a *Mediterranean* Place as can be desired, whence the Confluence of Strangers is but small, and the Manufacture of Linnen employs chiefly the poor People of the place, as well as of the Country round about . . . For these Reasons the People of this City seem most proper for a *Standard ;* and the rather, for that the *Births* do, a small matter, exceed the *Funerals*. The only thing wanting is the Number of the whole People, which in some measure I have endeavoured to supply by comparison of the *Mortality* of the People of all Ages, which I shall from the said Bills trace out with all the Acuracy possible.

The device which Halley applied in order to supply the wanting number of inhabitants was most ingenious. He first ascertained that in the average of the five years, 1687–1691, 1,238 children had been born, of whom 348 died under one year, so that 890 survived the first year of age. He fully realized that neither the yearly number of births nor the number of those surviving the first year of age could give him a clue to the population under one. But for one year at least, 1691, in which 1,218 children had been born he had a note from Neumann saying, " Nati anno nondum elapso iterum vita functi 226." He thus knew that of the 1,218 children born in 1691, 226 died during that year, so that 992 survived the 31st of December. He therefrom concluded that with 1,238 births and 348 deaths at age 0 to 1, the population under one was 1,000. He found in a similar manner the population at each subsequent year of age (1 to 2 : 855, etc.) and obtained a total of 34,000 inhabitants : [1]

From these Considerations I have formed the *adjoyned Table*, whose Uses are manifold, and give a more just *Idea* of the *State* and *Condition* of *Mankind*, than any thing yet extant that I know of. It exhibits the *Number* of *People* in the City of *Breslaw* of all Ages, from the *Birth* to extream *Old Age*, and thereby shews the Chances

[1] See *ibid.*, p. 600. See also Graetzer, J., *Edmund Halley und Caspar Neumann*, Breslau, 1883 ; Böckh, R., " Halley als Statistiker," *Bulletin de l'institut international de statistique*, 1893, vol. vii, i, pp. 1–24 ; Westergaard, Harald, *Contributions to the History of Statistics*, pp. 32–36, London, 1932.

of *Mortality* at all *Ages*, and likewise how to make a certain Estimate of the value of *Annuities* for *Lives*, which hitherto has been only done by an imaginary *Valuation:* Also the *Chances* that there are that a *Person* of any *Age* proposed does live to any other *Age* given; with many more, as I shall hereafter shew. This *Table* does shew the *number* of *Persons* that are living in the *Age* current annexed thereto, as follows:

Age.	Persons.
7	5547
14	4584
21	4270
28	3964
35	3604
42	3178
49	2709
56	2194
63	1694
70	1204
77	692
84	253
100	107
	34,000

Sum Total.

Age. Curt.	Per-sons.	Age. Curt.	Per-sons.	Age. Curt.	Per-sons.	Age. Curt.	Per-sons.	Age. Curt.	Per-sons.	Age. Curt.	Per-sons.	Age. Curt.	Per-sons.
1	1000	8	680	15	628	22	586	29	539	36	481		
2	855	9	670	16	622	23	579	30	531	37	472		
3	798	10	661	17	616	24	573	31	523	38	463		
4	760	11	653	18	610	25	567	32	515	39	454		
5	732	12	646	19	604	26	560	33	507	40	445		
6	710	13	640	20	598	27	553	34	499	41	436		
7	692	14	634	21	592	28	546	35	490	42	427		
43	417	50	346	57	272	64	202	71	131	78	58		
44	407	51	335	58	262	65	192	72	120	79	49		
45	397	52	324	59	252	66	182	73	109	80	41		
46	387	53	313	60	242	67	172	74	98	81	34		
47	377	54	302	61	232	68	162	75	88	82	28		
48	367	55	292	62	222	69	152	76	78	83	23		
49	357	56	282	63	212	70	142	77	68	84	20		

This table, then, practically gives what we call to-day the *stationary population* derived from the life table, i.e. *the age composition of a population, which with an equal annual number of births and deaths would be constantly subject to the same mortality.* It goes without saying that the age composition of the population of Breslau actually was not that of a " stationary " population. Halley's merit consists in having shown what would have been the age composition of Breslau under certain definite assumptions.

Halley's method of constructing a life table, based exclusively on death data, has been very often misunderstood,[1] and many of his successors committed grave errors in trying to use it, while others introduced slight improvements. But in a general way it may be said that Halley's method for about 175 years was the usual method for constructing life tables.

In the meantime, however, Per Wargentin (1766) had suggested a life table, based on death and census data combined [2] by relating the average number of deaths in Sweden, 1755–1757, for each of 21 age groups to the corresponding number of inhabitants registered in 1757. He computed similar tables for 1758–1760 and 1761–1763. Little attention, however, was paid for nearly a century to his method, which has been elaborated and improved upon by Milne, Moser, Böckh, Knapp, Pesch, and others. It lies outside the scope of this volume to enter into the many details involved in computing a correct complete life table based on the principle first suggested by Wargentin. We shall confine ourselves to outlining the features with which the student of population growth must be familiar in order to be able to use a complete life table and also to construct an abridged life table sufficiently correct for measuring the net reproduction of a population.

Mortality in the first year of age is particularly high ; its computation, therefore, deserves particular care. If treated by itself, without regard to mortality at higher ages, it is usually computed by relating the deaths of a calendar year to

[1] This was largely the fault of Halley who was not sufficiently explicit as to the data and to the methods he used.

[2] See " Mortaliteten i Sverige, i anledning af Tabell-Verket," *Kongl. Svenska Vetenskaps Academiens Handlingar*, vol. xxvii, p. 6.

the births of the same calendar year. Thus, in 1933, the number of births in England was 580,413 and the number of deaths of children under one was 36,960. Infant mortality was therefore considered to be $\frac{36,960}{580,413}$=63·68 per 1,000.[1] But part of the 36,960 children who died under one in 1933 were born in 1932. If the number of births had been about the same in 1933 as in 1932 this crude method of computing infant mortality for 1933 might have led to approximately correct results. But the number of births in 1932 actually was 613,972. The number of children exposed to the risk of dying under one in 1933 was then evidently larger than indicated by the number of births in 1933, and the official infant mortality rate, therefore, is too high. But what was the actual number of live-born who were exposed to death in 1933 before the completion of their first year of age, *i.e.* the number to which the deaths under one occurring in 1933 should be related ?

If all the deceased infants died on their day of birth they would all die in the calendar year in which they were born, and their deaths should be related to the births of the same calendar year. If, on the other hand, all the deceased infants died at the end of their first year of age they would all die in the calendar year following the year of their birth, and their deaths should be related to the births of the preceding calendar year. But since actually mortality is much higher at the beginning than at the end of the first year of age the majority of the infants deceased in a calendar year have been born in this calendar year, and a small minority in the preceding one, the ratio, as a rule, being about 7 : 3.

There is one very simple method of relating the deaths of infants to the correct number of births. It consists in relating the number of children born in a calendar year and deceased under one (in this or the following calendar year) to the total births of the first calendar year, *i.e.* in relating, for instance, the number of children who were born in 1933 and died under

[1] See *The Registrar-General's Statistical Review of England and Wales for the Year* 1933, Tables, Part I, Medical, p. 64.

one (either in 1933 or 1934) to the number of births in 1933. But the disadvantage of this otherwise quite satisfactory method is that the deaths are taken from two different years which may experience a quite different mortality, and that the ratio which is computed from only part of the deaths of both years does not adequately express mortality of either of the two years. For the purpose of a life table to be computed for a given calendar year, another method, therefore, must be applied by which all deaths of infants occurring in this calendar year are related to the pertaining number of births occurring in this or the preceding calendar year.

In order to survive the first year of age, a child must first survive to the end of the calendar year in which it is born, and then live long enough in the next calendar year to attain its second birthday. The probability of any live-born surviving the first year of age is therefore the probability of both these events happening. If

p indicates the probability of surviving the first year of age

p' the probability of surviving to the end of the calendar year of birth

p'' the probability of living long enough in the next calendar year to survive the first year of age

$$p = p' \times p''.$$

If then,

n' indicates the children born in the preceding calendar year

n'' the children born in the current calendar year

m' the children born and deceased in the preceding calendar year

m'' the children born in the preceding calendar year and deceased under one in the current calendar year

m''' the children born and deceased in the current calendar year

$$p' = \frac{n' - m' - m''}{n' - m'} \qquad p'' = \frac{n'' - m'''}{n''}$$

We shall illustrate here this method by the example of female infant mortality in Germany, 1925 :

n' (born 1924)=614,548
n'' (born 1925)=625,832
m' (born 1924 and deceased 1924)=44,337
m'' (born 1924 and deceased 1925)=15,459
m''' (born 1925 and deceased 1925)=43,298

$$p=\frac{614,548-44,337-15,459}{614,548-44,337}\times\frac{625,832-43,298}{625,832}=905\cdot58$$

per 1,000.

Infant mortality, computed by this method, would thus be

$$1-0\cdot90558=94\cdot42 \text{ per } 1,000 \text{ live-born.}$$

Which is then the number of births (x) to which the deaths in the current calendar year ($m''+m'''$) should be related? It is evident that

$$\frac{m''+m'''}{x}=1-p=1-\frac{(n'-m'-m'')(n''-m''')}{(n'-m')n''}$$

$$x=\frac{n''(n'-m')(m''+m''')}{n''m''+(n'-m'-m'')m'''}$$

Another way of obtaining this formula is:

$$p=\left(1-\frac{m''}{n'-m'}\right)\left(1-\frac{m'''}{n''}\right)$$

$$=1-\frac{m''}{n'-m'}-\frac{m'''}{n''}+\frac{m''m'''}{(n'-m')n''}$$

Therefore $$\frac{m''+m'''}{x}=\frac{m''}{n'-m'}+\frac{m'''}{n''}-\frac{m''m'''}{(n'-m')n''}$$

and $$x=\frac{n''(n'-m')(m''+m''')}{n''m''+(n'-m'-m'')m'''}$$

The number of births to which the 15,459+43,298=58,757 girls deceased under one in 1925 should be related is thus:

$$\frac{625,832(614,548-44,337)(15,459+43,298)}{(625,832\times15,459)+(614,548-44,337-15,459)43,298}$$

$$=622,294$$

But the number of female births was actually 614,548 in 1924, and 625,832 in 1925. The correct number of births

to which the deaths under one in 1925 ($m''+m'''$) should be related, is then

$$0{\cdot}31n'+0{\cdot}69n''$$

In some other cases the correct number of female births appears to be as follows :

Country	Year	Births
Germany . .	1924	$0{\cdot}10n'+0{\cdot}90n''$
,, . . .	1926	$0{\cdot}24n'+0{\cdot}76n''$
Prussia . . .	1930	$0{\cdot}15n'+0{\cdot}85n''$
,, . . .	1931	$0{\cdot}23n'+0{\cdot}77n''$
,, . . .	1932	$0{\cdot}21n'+0{\cdot}79n''$
Austria . . .	1913	$0{\cdot}30n'+0{\cdot}70n''$
,, . . .	1928	$0{\cdot}21n'+0{\cdot}79n''$
,, . . .	1931	$0{\cdot}23n'+0{\cdot}77n''$
,, . . .	1932	$0{\cdot}26n'+0{\cdot}74n''$
France . . .	1925	$0{\cdot}27n'+0{\cdot}73n''$
,, . . .	1926	
,, . . .	1927	$0{\cdot}20n'+0{\cdot}80n''$

As a rule, the number of births to which the deaths of infants of a calendar year should be related lies between the number of births in this year and the number of births in the preceding year. But this is not necessarily true. Let us assume $n'=1{,}050$, $n''=1{,}000$, $m'=200$, $m''=100$.

If $m'''>320$, then $x>1{,}050$.

,, m <150, then $x<1{,}000$.

For France, the number of births to which the deaths of infants in 1926 should be related was actually slightly higher than both the births of 1925 and 1926.

For countries like England, where the number of deceased is not known by calendar years of birth, neither of these two methods can be used for ascertaining the number of births to which the deaths of infants should be related, and we do not know of any other method for finding this number accurately. We shall, however, briefly indicate three methods which have been used for this purpose in the English official statistics.

When the number of births had dropped considerably from 1916 to 1917, the error resulting from relating the deaths

of infants in 1917 to the births of 1917 became obvious. The Registrar-General then stated : [1]

> This is the first occasion upon which this difficulty, the possibility of which has, of course, been widely recognised as a theoretical weakness in the accepted method of statement, has ever attained such serious proportions in this country.

Having ascertained that the number of deaths under one per 1,000 births of the same calendar year had increased from 91·21 in 1916 to 96·48 in 1917, while the number of deaths under one per 1,000 of the population under one had decreased simultaneously from 98·15 to 94·44, he used two other methods for obtaining a more accurate infant mortality rate :

> (1) If . . . we adopt births as the standard for the first three and population under one year for the remaining nine months we find a movement of the composite mortality rate so arrived at from 94·06 in 1916 to 95·60 in 1917, or an increase of 1·54 as against an increase of 5·27 on the basis of births and a decrease of 3·71 on the basis of population.[2]
>
> (2) As about 70 per cent. of the deaths in any year are those of infants born in the same year and 30 per cent. only those of infants born in the previous year, it seems reasonable to give corresponding weight to the births of the two years in fixing the basis for more precise measurement of the mortality. Taking, accordingly, 30 per cent. of the births in 1916 and 70 per cent. of those in 1917 we obtain an infant mortality rate of 91·7. This compares with a rate for 1916, similarly calculated, of 90·2, showing an increase in 1917 of 1·5 per 1,000 births. This is exactly the increase already arrived at by consideration of the movement of mortality at separate portions of the year of life, and the correspondence of the two results may be accepted as measuring the movement of mortality with sufficient accuracy. It also suggests that when, on occasions like the present, a more accurate basis of measurement than the births registered in the year is required, it may be provided by this method, which is very easily applied and is universally available.[3]

As about 70 per cent of the deaths in any yeai are those of infants born in the same year and 30 per cent only those of infants born in the previous year, it may seem reasonable indeed, at first sight, to give corresponding weight to the

[1] *Eightieth Report* (1917), p. xxix.
[2] *Ibid.*, p. xxxi.
[3] *Ibid.*, pp. xxxi–xxxii.

births of the two years in fixing the basis for a more precise measurement of the mortality. But the reader of the foregoing pages will have realized that such a procedure would be quite unsafe. Let us test the result of the computation, assuming that actually of the infants deceased in 1916, 30 per cent were born in 1915 and 70 per cent in 1916, and of the infants deceased in 1917, 30 per cent in 1916 and 70 per cent in 1917 :

Survivors, 1916 :

$$\frac{814,614-62,566-21,494}{814,614-62,566}\times\frac{785,520-50,152}{785,520}=909{\cdot}40 \text{ per } 1,000$$

Survivors, 1917 :

$$\frac{785,520-50,152-19,345}{785,520-50,152}\times\frac{668,346-45,138}{668,346}=907{\cdot}93 \text{ per } 1,000$$

Infant mortality would be 90·60 per 1,000 in 1916, and 92·07 per 1,000 in 1917. The number of births to which the deaths of infants should be related would be :

$$1916:\ \frac{71,646}{0{\cdot}09060}=790,786=(0{\cdot}18\times 814,614)+(0{\cdot}82\times 785,520)$$

$$1917:\ \frac{64,483}{0{\cdot}09207}=700,392=(0{\cdot}27\times 785,520)+(0{\cdot}73\times 668,346)$$

Although we have assumed for both years that 30 per cent of the deceased infants were born in the preceding calendar year, the births of the preceding calendar years should be taken account of only to the extent of 18 per cent in 1916 and 27 per cent in 1917.

It may be objected that our computation after all reveals the same increase of the infant mortality rate as that shown by the Registrar-General's computations (1·5 points per 1,000), and that the correspondence of the three results may be accepted as a proof that the two cruder methods lead to as accurate results as the more refined method which we suggested. But such a conclusion would be quite erroneous. In applying our method to the data for 1916 and 1917, we have assumed with the Registrar-General that both in 1916 and 1917, 30 per cent of the deceased infants were born in the preceding

year. But why did the Registrar-General employ different methods from those he used formerly? Because the normal proportion of 30 : 70 had been disturbed in 1917! The results of computations which have been made because such a proportion no longer prevails, and which assume that this proportion is still prevailing, certainly are not convincing. Moreover, the Registrar-General himself, only a few years later, reached the conclusion that infant mortality in 1917 had *not* been higher than in 1916 (see p. 176).

When in the fall of 1919 the births began to increase, he realized indeed that the proportions of 30 : 70 "cannot be wholly applicable to this very exceptional year," [1] and in his Report for 1920 he proposed a new method: [2]

(3) As has been pointed out in previous reports the conventional infant mortality rate is apt to be misleading in a period of rapidly changing birth-rates, such as have been recently experienced. The rough method of correction hitherto employed increases the rate for 1920 from 80 to 87. This method consists in relating the infant deaths of the year not to the births of the same year alone, but to those of the two years in which infants dying in the first year of life have been born, *i.e.*, for the deaths of 1920, the births of 1919 and 1920. These were taken in the approximate proportion in which the infant deaths of any one calendar year occur amongst children born in that and in the preceding calendar year—70 and 30 per cent. respectively.

But in last year's report it was pointed out that these proportions could not be wholly applicable to the deaths of 1919, owing to the fact that the increase of the birth-rate in that year was practically confined to its fourth quarter. It has seemed desirable, therefore, to seek a somewhat less rough and ready means of correction, which has been found by relating the deaths occurring during each quarter of the year in each portion of the first year of life to the births of the two quarters in which the infants concerned may have been born.

The deaths must be divided between the infants born in these two quarters in certain approximate proportions determined by the age at death Thus for infants dying within 24 hours of birth it may be assumed that all births were registered during the same quarter as the deaths, but for those dying at 1–7 days of age a few of the births will have been registered in the previous quarter. For infants dying at 9–12 months of age the two possible quarters of birth are the

[1] *Eighty-Second Report* (1919), p. xli.
[2] *Eighty-Third Report* (1920), pp. xxviii–xxix.

third and fourth preceding that of death. But when death occurs in the tenth month of life the great bulk of the infants must have been born in the third preceding quarter, and when it occurs in the twelfth month of life, in the fourth preceding quarter. The distribution between the two quarters of birth concerned in each case has been made by assigning the following proportions of deaths to the more recent of the two, the remainder falling to the more remote—age at death under 1 day, 100 per cent. ; 1–7 days, 98 per cent. ; 1–2 weeks, 89 per cent. ; 2–3 weeks, 81 per cent. ; 3–4 weeks, 73 per cent. ; 4 weeks–2 months, 54 per cent. ; 2–3 months, 17 per cent. ; 3–4 months $\frac{5}{6}$; 4–5 months, $\frac{1}{2}$; 5–6 months, $\frac{1}{6}$; 6–7 months, $\frac{5}{6}$; 7–8 months, $\frac{1}{2}$; 8–9 months, $\frac{1}{6}$; 9–10 months, $\frac{5}{6}$; 10–11 months, $\frac{1}{2}$; 11–12 months, $\frac{1}{6}$.

Such a " standardized " infant mortality rate has been computed by the Registrar-General for each year from 1911 to 1925 : [1]

Year	Crude Rate	Standardized Rate	Year	Crude Rate	Standardized Rate
1911	130·1	129·2	1919	89·1	93·2
1912	94·8	94·7	1920	79·9	84·5
1913	108·4	108·9	1921	82·8	81·2
1914	104·6	104·4	1922	77·1	74·7
1915	109·7	105·8	1923	69·4	69·2
1916	91·2	91·1	1924	75·1	74·2
1917	96·5	91·1	1925	75·0	74·5
1918	97·2	97·9			

" As in 1926 it had become evident that the correction, which was without effect in two of the three preceding years, was no longer required, it was then discontinued." [2] But it is doubtful whether this method in the critical years led to better results than the " rough method of correction " which consisted in taking 30 per cent of the births of the preceding and 70 per cent of the births of the current year. The " standardized " rate for 1920 was 84·5, as against a crude rate of 79·9 and a roughly corrected rate of 87·2. If, however, one distributes the deaths of infants by calendar years of birth according to the rules suggested by the Registrar-General,

[1] See *ibid.*, p. xxxi ; *Statistical Review*, 1921, Text, p. 11 ; 1922, Text, p. 16 ; 1923, Text, p. 11 ; 1924, Text, p. 11 ; 1925, Text, p. 9 ; 1926, Text, p. 6.

[2] *Statistical Review*, 1930, Text, p. 6.

and then measures infant mortality through the formula given above, one obtains a rate of 88·4, which is much closer to the roughly corrected than to the " standardized " rate.

Since mortality in the other years of age is more or less constant for the entire year, a very simple method may be applied for computing the number of survivors at the years above one. If

f_n indicates the mean number of females n years old
d_n the females deceased at age n years
l_n the females surviving n years of age

$$l_{n+1}=\frac{f_n-(d_n\times 0{\cdot}5)}{f_n+(d_n\times 0{\cdot}5)}\times l_n \ ^{1}$$

If the life table is computed by quinquennial intervals the formula for the age group 5 to 9 years would thus read :

$$l_{10}=\frac{f_{5-9}-(d_{5-9}\times 2{\cdot}5)}{f_{5-9}+(d_{5-9}\times 2{\cdot}5)}\times l_5$$

It is only for the age group 1 to 4 years, where mortality at the beginning is noticeably higher than at the end that the formula should be slightly modified and read :

$$l_5=\frac{f_{1-4}-(d_{1-4}\times 1{\cdot}2)}{f_{1-4}+(d_{1-4}\times 2{\cdot}8)}\times l_1$$

We shall now illustrate the construction of the whole life table through the example of England 1933 (females).

Basic Data

Births, 1932 : 299,565 ; Births, 1933 : 283,684 ; Deaths under one, 1933 : 15,649.

[1] The principle underlying this formula can be explained as follows. If L_n indicates the actual number of females who in the course of the calendar year under consideration reach the age n years,

$$L_n=f_n+\tfrac{1}{2}d_n$$

$$l_{n+1}=\frac{L_n-d_n}{L_n}\times l_n$$

$$=\frac{f_n+\frac{1}{2}d_n-d_n}{f_n+\frac{1}{2}d_n}\times l_n$$

Years of Age	Population	Deaths
1–4	1,167,900	7,271
5–9	1,541,400	3,267
10–14	1,723,900	2,371
etc.		

Surviving 1 year :

$$1{,}000-\frac{15{,}649}{(0{\cdot}3\times 299{,}565)+(0{\cdot}7\times 283{,}684)}\times 1{,}000$$
$$=945{\cdot}748$$

Surviving 5 years :

$$\frac{1{,}167{,}900-(7{,}271\times 1{\cdot}2)}{1{,}167{,}900+(7{,}271\times 2{\cdot}8)}\times 945{\cdot}748=922{\cdot}599$$

Surviving 10 years :

$$\frac{1{,}541{,}400-(3{,}267\times 2{\cdot}5)}{1{,}541{,}400+(3{,}267\times 2{\cdot}5)}\times 922{\cdot}599=912{\cdot}873$$

Surviving 15 years :

$$\frac{1{,}723{,}900-(2{,}371\times 2{\cdot}5)}{1{,}723{,}900+(2{,}371\times 2{\cdot}5)}\times 912{\cdot}873=906{\cdot}617$$

etc.

Table 48 shows in cols. (1) and (2) the life table for males and females, starting with 1,000 male live-born and 1,000 female live-born respectively. Is it possible to derive therefrom a life table for the total population ? If the number of live-born were the same for each sex, one-half the sum of the male and female survivors would give us for each age the number of survivors for the total population. We should thus obtain the same results as if we had computed a life table for males and one for females, starting for each sex with 500 live-born, and had added the numbers of survivors at each age. But since the number of female live-born differs from that of the male live-born we have to take account of the actual proportion of the sexes at birth. In computing our life tables for males and females in England, 1933, we reckoned with 302,032 male and 288,448 female births. We would, therefore, have to start with 511·5 male and 488·5 female live-born, and the number of survivors for both sexes combined would be :

$$\text{age } 1=(929{\cdot}44\times 511{\cdot}5)+(945{\cdot}75\times 488{\cdot}5)=937{\cdot}41$$
$$\text{age } 5=(904{\cdot}34\times 511{\cdot}5)+(922{\cdot}60\times 488{\cdot}5)=913{\cdot}26$$

etc.

TABLE 48.—ABRIDGED LIFE TABLE, ENGLAND, 1933.

Years of Age	Survivors		Stationary Population	
	M.	F.	M.	F.
	(1)	(2)	(3)	(4)
0	1,000	1,000	945·5	958·0
1	929·44	945·75	3,667·2	3,736·7
5	904·34	922·60	4,496·2	4,588·7
10	894·15	912·87	4,454·2	4,548·7
15	887·55	906·62	4,409·6	4,507·5
20	876·30	896·39	4,345·8	4,449·4
25	862·02	883·39	4,274·7	4,382·5
30	847·87	869·63	4,200·3	4,312·8
35	832·26	855·48	4,111·4	4,232·9
40	812·30	837·68	3,995·4	4,135·8
45	785·87	816·62	3,835·3	4,012·6
50	748·25	788·43	3,617·9	3·848·5
55	698·91	750·99	3,330·5	3,628·5
60	633·29	700·43	2,954·8	3,324·4
65	548·63	629·32	2,461·8	2,899·9
70	436·09	530·65	1,842·1	2,317·3
75	300·73	396·29	1,156·7	1,603·3
80	161·95	245·03	552·5	880·5
85	59·06	107·16	174·7	332·1
90	10·82	25·69	29·8	73·6
95	1·11	3·75	3·1	10·5
100	0·15	0·44	0·1	0·4
102	—	—		
Total .	—	—	58,859·6	62,784·6

The next problem which arises is how to compute the stationary population, *i.e.* the age composition of a population which with an equal number of births and deaths would be constantly subject to the same mortality. If l_n indicates the number of females surviving n years, and f_n the number of those living at age n years, f_n must be smaller than l_n, but larger than l_{n+1}, and the formula

$$f_n = \tfrac{1}{2}(l_n + l_{n+1})$$

will provide a result sufficiently approximate to the truth. With an abridged life table computed for quinquennial age groups the number of those living, for instance, at age 15 to 19 ($f_{15\text{-}19}$) would be

$$2\tfrac{1}{2}(l_{15} + l_{20})$$

The number of females living at age 15 to 19 in the stationary population according to the life table for England, 1933, would thus be

$$2\tfrac{1}{2}(906{\cdot}62 + 896{\cdot}39) = 4{,}507{\cdot}5$$

But f_n expresses at the same time the number of years which l_n have lived in the age interval between n and $n+1$ years. The figure 4,507·5 thus expresses also the number of years which 1,000 live-born girls, according to mortality of England, 1933, would have lived between the age of 15 and 20. Table 48, therefore, shows in cols. (3) and (4) both the stationary population for each age period and the number of years lived in each age period by 1,000 live-born.

We have stated that the average of the survivors at two consecutive years of age gives approximately the stationary population at the corresponding age interval. The assumption underlying this statement is that mortality will be approximately constant during the whole age interval. But this is certainly not true of the first year of age, since the risk of death is much larger at the beginning than at the end. In ascertaining the stationary population this difference should be taken account of by computing the survival at small age intervals for the first year of life. Table 49 illustrates how this computation may be carried out for the females, England, 1933.

TABLE 49.—LIFE TABLE FOR FEMALES FIRST YEAR OF AGE, ENGLAND, 1933.

Age	Population surviving	Deaths	Death rate per 1,000	Survivors per 1,000 Live-born	Years lived by 1,000 Females
0 days	283,684			1,000	
		2,817	9·93		2·726
1 day	280,867			990·07	
		881	3·14		2·708
2 days	279,986			986·96	
		720	2·57		2·701
3 days	279,266			984·43	
		458	1·64		2·695
4 days	278,808			982·81	
		316	1·13		2·691
5 days	278,492			981·70	
		249	0·89		2·688
6 days	278,243			980·82	
		185	0·67		2·686
7 days	278,058			980·17	
		1,014	3·65		18·76
2 weeks	277,044			976·59	
		762	2·75		18·70
3 weeks	276,282			973·91	
		535	1·94		18·66
4 weeks	275,747			972·02	
		2,352	8·53		167·06
3 months	273,395			963·73	
		2,129	7·79		239·99
6 months	271,266			956·23	
		1,680	6·19		238·32
9 months	269,586			950·30	
		1,551	5·75		236·89
1 year	268,035			944·84	
Total .	268,035	15,649	—	944·84	957·28

Of 283,684 live-born 2,817 or 9·93 per 1,000 died during the first day of life and 990·07 survived. The stationary female population under one day was $\frac{1{,}000+990{\cdot}07}{2}$ or 995·03, and by the end of this day 1,000 live-born children had lived 995·03 days or 2·73 years. They would live 2·71 years on the second day of life and altogether 957·28 years in their first year of life. The stationary population under one year of age would then appear to be 957·28. But in computing this life table for the first year of age we started from the number

of children born in 1933, and thus neglected the fact that the children born in 1932, which, inasmuch as they survived the year 1932, were exposed to death under one during part of the year 1933, were more numerous. We, therefore, have raised the stationary population under one to 958.

If the stationary population of a certain age group indicates the number of years lived by 1,000 live-born according to the mortality in the period under consideration, the total stationary population evidently indicates the total number of years lived by such 1,000 live-born. In the example of England, 1933, this total would be 58,860 for males and 62,785 for females. One thousand male live-born would then live 58,860 years and 1,000 female live-born 62,785 years, and the mean expectation of life at birth would be 58·860 years for males and 62·785 years for females. The stationary population and the mean expectation of life at birth for the two sexes combined would be found again by multiplying the figures for males by 0·5115 and the figures for females by 0·4885 and adding the products. The mean expectation of life at birth for the whole population would then appear to be 60·777 years.

If the mean expectation of life at birth is constantly 60·777 years, $\frac{1}{60{\cdot}777}$ or 16·45 per 1,000 die every year, and 16·45 would then be the death rate derived from the life table. It eliminates all the misleading effects of the actual age composition of the population which is the result of changing fertility and mortality, and of emigration and immigration stretching over a past period of nearly a 100 years. The death rate derived from the life table, which is also called the death rate of the stationary population, is then a perfect gauge of current mortality.

Table 50 shows for various countries the mean expectation of life at birth, the correct death rate derived from the life table, *i.e.* the death rate of the stationary population, and the crude death, *i.e.* the death rate of the actual population. A study of this table leads to the following results :

(1) The crude death rate may be lower or higher than the

correct death rate. If we put the correct death rate = 100, the crude death rate was below 70 in Denmark, 1921–1930, in Germany, 1924–1926, in Holland, 1921–1930, in Australia, 1891–1922, in New Zealand, 1891–1922. It was above 100 in Germany, 1871–1881, in Sweden, 1755–1775, in Austria, 1866–1880. The age composition of the actual population may thus be more favourable or less favourable than the age composition of the stationary population.

(2) For the last 50 years the crude death rate everywhere has been lower than the correct death rate. The gap between the two rates has widened in most countries up to a few years ago, while recently it has narrowed slightly. The widening of the gap indicates that due to the decrease in the proportion of children the age composition of the population tended to reduce the number of deaths. The recent narrowing of the gap indicates that the reduction of deaths due to the decrease of fertility has been more than offset by the increase of deaths due to the increasing proportion of old people.

(3) Correct death rates of various countries differ at present much less than crude death rates. While the crude death rate of France, 1920–1923 (17·5), was twice as high as that of New Zealand, 1921–1922 (8·7), the correct death rate of France (18·5) exceeded that of New Zealand (15·6) by less than one-fifth.

(4) The curve of the crude death rate for many decades conveyed a grossly exaggerated picture of the reduction of mortality; for recent years, it makes the reduction appear much smaller than it actually was. In England the crude death rate thus decreased from 1838–1854 to 1920–1922 by as much as 45 per cent, while the correct death rate decreased only by 29 per cent. Since 1920–1922, however, the crude death rate has decreased by only 1 per cent, while the correct death rate decreased by as much as 5 per cent. The difference is still more striking for the female sex taken by itself: the crude death rate decreased from 1838–1854 to 1920–1922 by 46 per cent and increased from 1920–1922 to 1933 by 1 per cent; the correct death rate decreased in the former period by 30 and in the latter period by 5 per cent.

TABLE 50.—MEAN EXPECTATION OF LIFE OF NEWLY-BORN AND DEATH RATES OF STATIONARY AND OF ACTUAL POPULATION.

Period	Mean Expectation of Life in Years			Death Rate of Stationary Population			Death Rate of Actual Population		
	M.	F.	Total	M.	F.	Total	M.	F.	Total
1. WESTERN AND NORTHERN EUROPE									
Belgium									
1881–90	43·59	46·64	45·06	22·94	21·44	22·19	21·60	19·37	20·49
1891–00	45·39	48·84	47·08	22·0	20·5	21·2	20·37	18·26	19·31
Denmark									
1835–44	40·87	43·31	42·07	24·5	23·1	23·8	21·26	20·12	20·68
1840–49	40·88	43·45	42·14	24·5	23·0	23·7	21·05	20·03	20·59
1845–49	39·83	42·59	41·18	25·1	23·5	24·3	21·88	20·59	21·23
1850–54	41·7	44·5	43·1	24·0	22·5	23·2	20·77	19·47	20·11
1855–59	43·0	45·2	44·1	23·3	22·1	22·7	21·38	20·20	20·80
1860–69	43·6	45·5	44·5	22·9	22·0	22·5	20·54	19·47	20·00
1870–79	45·6	47·4	46·5	21·9	21·0	21·5	19·88	18·73	19·29
1880–89	46·8	48·9	47·8	21·4	20·4	20·9	19·37	18·00	18·68
1885–94	46·9	49·2	48·0	21·3	20·3	20·8	19·47	18·03	18·73
1895–00	50·2	53·2	51·7	19·9	18·8	19·4	17·32	15·63	16·46
1901–05	52·9	56·2	54·5	18·9	17·8	18·3	15·59	14·09	14·82
1906–10	54·9	57·9	56·4	18·2	17·3	17·7	14·30	13·10	13·68
1911–15	56·2	59·2	57·7	17·8	16·9	17·3	13·34	12·39	12·85
1916–20	55·8	58·1	56·9	17·9	17·2	17·6	13·32	12·89	13·10
1921–25	60·3	61·9	61·1	16·6	16·2	16·4	11·26	11·24	11·25
1926–30	60·9	62·6	61·7	16·4	16·0	16·2	11·10	11·14	11·12
England and Wales									
1838–54	39·91	41·85	40·86	25·05	23·90	24·47	23·27	21·65	22·45
1871–80	41·35	44·62	42·96	24·18	22·41	23·28	21·64	19·40	20·49
1881–90	43·66	47·18	45·39	22·90	21·20	22·03	19·79	17·74	18·73
1891–00	44·13	47·77	45·92	22·66	20·93	21·78	19·32	17·14	18·19
1901–10	48·53	52·38	50·42	20·60	19·09	19·83	16·37	14·40	15·36
1910–12	51·50	55·35	53·38	19·42	18·07	18·73	14·67	12·93	13·77
1920–22	55·62	59·58	57·55	17·98	16·78	17·38	13·31	11·60	12·42
1933	58·86	62·78	60·78	16·99	15·93	16·45	12·95	11·71	12·30
Scotland									
1861–70	40·32	43·85	41·65	24·80	22·80	24·01	23·07	21·21	22·06
1871	39·79	42·05	40·89	25·13	23·78	24·45	22·92	21·52	22·19
1871–80	40·95	43·79	42·45	24·42	22·83	23·56	22·55	20·75	21·61
1881–90	43·92	46·32	44·97	22·77	21·59	22·24	19·77	18·69	19·21
1891–00	44·71	47·47	46·06	22·37	21·06	21·71	19·00	17·98	18·47
1910–12	50·10	53·18	51·61	19·96	18·80	19·38	15·58	14·74	15·15
1920–22	53·08	56·35	54·68	18·84	17·75	18·29	14·76	13·59	14·15
1930–32	56·0	59·5	57·7	17·9	16·8	17·3	13·97	12·86	13·39
Northern Ireland									
1890–92	46·3	45·7	46·0	21·9	21·6	21·7	20·21	20·53	20·38
1900–02	47·1	46·7	46·9	21·2	21·4	21·3	19·59	19·68	19·64
1910–12	50·7	51·0	50·8	19·7	19·6	19·7	17·38	17·59	17·49
1925–27	55·42	56·11	55·75	18·05	17·82	17·94	15·05	15·10	15·08
Irish Free State									
1870–72	49·6	50·9	50·3	20·2	19·6	19·9	17·33	16·39	16·85
1880–82	49·4	49·9	49·6	20·3	20·0	20·2	18·10	17·45	17·77
1890–92	49·1	49·2	49·1	20·4	20·3	20·4	17·83	17·99	17·91
1900–02	49·3	49·6	49·4	20·3	20·2	20·2	17·85	17·65	17·75
1910–12	53·6	54·1	53·8	18·7	18·5	18·6	16·32	16·37	16·35
1925–27	57·37	57·93	57·64	17·43	17·26	17·35	14·33	14·63	14·48

TABLE 50.—MEAN EXPECTATION OF LIFE OF NEWLY-BORN AND DEATH RATES OF STATIONARY AND OF ACTUAL POPULATION—*continued.*

Period	Mean Expectation of Life in Years			Death Rate of Stationary Population			Death Rate of Actual Population		
	M.	F.	Total	M.	F.	Total	M.	F.	Total
				France					
1840–59	39·30	40·99	40·05	25·45	24·40	24·97	23·35	22·94	23·13
1861–65	39·05	40·61	39·81	25·61	24·63	25·12	23·05	22·61	22·84
1877–81	40½	43½	42½	24·5	23·0	23·8	23·28	21·60	22·44
1898–03	45·28	48·70	46·95	22·09	20·53	21·30	21·82	19·67	20·73
1908–13	48·50	52·42	50·42	20·6	19·1	19·8	19·70	17·52	18·59
1920–23	52·17	55·86	54·10	19·2	17·9	18·5	18·72	16·41	17·51
				Germany					
1871/2–80/1	35·58	38·45	36·97	28·11	26·01	27·04	28·81	25·63	27·19
1881–90	37·17	40·25	38·67	26·9	24·8	25·9	26·30	23·41	24·83
1891–00	40·56	43·97	42·23	24·66	22·74	23·68	23·33	20·79	22·04
1901–10	44·82	48·33	46·53	22·31	20·69	21·49	19·67	17·67	18·65
1910–11	47·41	50·68	49·00	21·1	19·7	20·4	17·50	16·02	16·75
1924–26	55·97	58·82	57·35	17·87	17·00	17·44	12·42	11·52	11·95
				Holland					
1840–51	34·94	37·76	36·33	28·62	26·48	27·52	28·63	26·24	27·41
1850–59	36·44	38·21	37·31	27·44	26·17	26·81	26·23	24·94	25·49
1870–79	38·4	40·7	39·5	26·0	24·6	25·3	25·28	23·57	24·49
1880–89	42·5	45·0	43·7	23·5	22·2	22·9	22·19	20·39	21·27
1890–99	46·2	49·0	47·6	21·6	20·4	21·0	19·36	17·87	18·67
1900–09	51·0	53·4	52·2	19·6	18·7	19·2	16·24	15·02	15·69
1910–20	55·1	57·1	56·1	18·2	17·5	17·9	13·63	13·00	13·31
1921–30	61·9	63·5	62·7	16·2	15·7	16·0	10·25	10·05	10·15
				Norway					
1821–30	45·0	48·0	46·5	22·2	20·8	21·5	19·53	18·21	18·85
1831–40	41·8	45·6	43·7	23·9	21·9	22·9	20·97	19·44	20·19
1841–50	44·5	47·9	46·2	22·5	20·9	21·7	18·80	17·43	18·10
1846–55	44·9	47·9	46·4	22·3	20·9	21·6	18·71	17·42	18·05
1856–65	47·40	49·95	48·64	21·10	20·02	20·56	18·29	17·21	17·74
1871/2–80/1	48·33	51·30	49·77	20·69	19·49	20·09	17·58	16·36	16·96
1881/2–90/1	48·73	51·21	49·94	20·52	19·53	20·03	17·57	16·43	17·02
1891/2–00/1	50·41	54·14	52·22	19·84	18·47	19·15	16·77	15·37	16·05
1901/2–10/1	54·82	57·70	56·26	18·2	17·3	17·8	14·37	13·68	14·02
1911/2–20/1	55·62	58·71	57·08	18·04	16·99	17·52	14·36	13·27	13·80
1921/2–30/1	60·98	63·84	62·37	16·40	15·66	16·03	11·47	11·04	11·25
				Sweden					
1755–75	33·9	36·6	35·2	29·5	27·3	28·4	30·05	27·88	28·92
1776–95	34·7	37·5	36·1	28·8	26·7	27·7	27·64	25·03	26·28
1816–40	39·50	43·56	41·43	25·32	22·96	24·14	24·85	22·15	23·45
1841–45	41·94	46·60	44·26	23·84	21·46	22·59	21·44	19·05	20·20
1846–50	41·38	45·59	43·47	24·16	21·94	23·00	22·09	19·88	20·95
1851–55	40·51	44·64	42·56	24·68	22·40	23·50	22·82	20·56	21·65
1856–60	40·48	44·15	42·31	24·70	22·65	23·64	22·73	20·78	21·73
1861–70	42·80	46·37	44·58	23·36	21·55	22·43	21·14	19·23	20·16
1871–80	45·27	48·62	46·95	22·08	20·58	21·30	19·12	17·46	18·27
1881–90	48·55	51·47	50·02	20·60	19·43	19·99	17·57	16·35	16·94
1891–00	50·94	53·63	52·30	19·63	18·65	19·1	16·84	15·91	16·36
1901–10	54·53	56·98	55·77	18·33	17·54	17·93	15·17	14·62	14·89
1911–15	56·49	59·24	57·88	17·7	16·9	17·3	14·25	13·82	14·03
1916–20	54·81	57·62	56·22	18·2	17·4	17·8	14·77	14·32	14·54
1921–25	60·72	62·95	61·84	16·5	15·9	16·2	11·98	12·13	12·06
1926–30	61·19	63·33	62·23	16·3	15·8	16·1	11·96	12·19	12·08
				Switzerland					
1876/7–80/1	40·53	43·19	41·83	24·67	23·15	23·91	24·46	21·73	23·07
1881–88	43·29	45·70	44·47	23·10	21·88	22·49	21·86	19·93	20·87
1889–00	45·70	48·47	47·06	21·88	20·63	21·25	20·06	18·41	19·22
1901–10	49·25	52·15	50·66	20·31	19·17	19·74	17·44	16·06	16·74
1920–21	54·48	57·50	55·95	18·4	17·4	17·9	14·03	13·19	13·60

TABLE 50.—MEAN EXPECTATION OF LIFE OF NEWLY-BORN AND DEATH RATES OF STATIONARY AND OF ACTUAL POPULATION—*continued.*

Period	Mean Expectation of Life in Years			Death Rate of Stationary Population			Death Rate of Actual Population		
	M.	F.	Total	M.	F.	Total	M.	F.	Total
2. EASTERN AND SOUTHERN EUROPE									
Austria									
1866–75	30·38	33·10	31·70	32·92	30·21	31·54	34·29	30·16	32·17
1870–80	30·95	33·80	32·33	32·31	29·58	30·93	33·18	29·38	31·24
1895–00	36·78	38·97	37·84	27·2	25·7	26·4	27·02	24·81	25·89
1900–01	37·77	39·87	38·79	26·5	25·1	25·8	25·66	23·74	24·68
1901–05	39·14	41·05	40·07	25·55	24·38	24·96	25·20	23·43	24·30
1906–10	40·64	42·84	41·71	24·60	23·34	23·97	23·25	21·51	22·36
Bulgaria									
1900–05	41·57	41·70	41·63	24·05	23·98	24·02	22·78	22·23	22·51
Finland									
1881–90	41·39	44·18	42·75	24·16	22·63	23·39	21·92	20·25	21·07
1891–00	42·9	45·6	44·2	23·3	21·9	22·6	20·48	19·00	19·73
1901–10	45·33	48·10	46·67	22·06	20·79	21·42	18·57	17·32	17·94
1911–20	43·41	49·12	46·18	23·04	20·36	21·66	19·34	16·67	17·81
1921–30	50·68	55·14	52·84	19·73	18·14	18·92	14·84	13·29	14·06
Italy									
1876–87	35½	35½	35½	28·5	28·2	28·4	28·92	27·95	28·44
1899–02	42·59	43·00	42·78	23·5	23·3	23·4	22·86	22·06	22·46
1901–10	43½	44½	44	22·9	22·5	22·7	22·17	21·01	21·58
1910–12	46·57	47·33	46·94	21·5	21·1	21·3	20·42	19·23	19·80
1921–22	49·27	50·75	49·99	20·3	19·7	20·0	18·17	16·92	17·54
1930–32	53·76	56·00	54·88	18·60	17·86	18·22	15·26	13·83	14·55
3. OTHER COUNTRIES									
United States of America									
11 Original Registration States, Total Population									
1900–02	47·88	50·70	49·24	20·89	19·72	20·31	17·04	15·53	16·24
1909–11	49·86	53·24	51·49	20·06	18·78	19·42	16·04	14·29	15·18
Massachusetts, Total Population									
1889–90	42·50	44·46	43·46	23·53	22·49	23·01	20·07	18·96	19·50
1893–97	44·09	46·61	45·32	22·68	21·46	22·07	20·09	18·39	19·17
1900–02	46·07	49·42	47·70	21·70	20·24	20·97	17·93	16·27	17·08
1909–11	49·33	53·06	51·15	20·27	18·85	19·55	16·45	14·84	15·63
Hawaii, Total Population									
1919–20	47·49	47·27	47·39	21·06	21·16	21·10	16·70	16·46	16·56
11 Original Registration States, White Population									
1900–02	48·23	51·08	49·62	20·73	19·58	20·15	16·87	15·26	16·07
1901–10	49·32	52·54	50·89	20·28	19·03	19·65	16·33	14·59	15·47
1909–11	50·23	53·62	51·88	19·91	18·65	19·27	15·86	14·13	15·00
1919–20	54·05	56·41	55·20	18·50	17·73	18·12	13·87	13·07	13·47
28 States, White Population									
1919–20	55·33	57·52	56·39	18·07	17·39	17·73	13·10	12·08	12·57
Australia (*excluding Aborigines*)									
1881–90	47·20	50·84	48·98	21·19	19·67	20·42	16·56	13·68	15·24
1891–00	51·08	54·76	52·87	19·58	18·26	18·92	14·30	11·55	13·01
1901–10	55·20	58·84	56·97	18·12	17·00	17·55	12·41	9·91	11·21
1920–22	59·15	63·31	61·17	16·91	15·80	16·35	11·03	8·65	9·86
New Zealand (*excluding Aborigines*)									
1891–95	55·29	58·09	56·66	18·09	17·22	17·65	11·12	9·04	10·14
1896–00	57·37	59·95	58·63	17·43	16·68	17·06	10·55	8·46	9·56
1901–05	58·09	60·55	59·29	17·21	16·52	16·87	10·92	8·75	9·90
1906–10	59·17	61·76	60·43	16·90	16·19	16·55	10·73	8·64	9·75
1911–15	60·96	63·48	62·19	16·40	15·75	16·08	10·29	8·05	9·22
1921–22	62·76	65·43	64·07	15·93	15·28	15·61	9·93	7·81	8·73

What is the range of the correct death rate? We saw that the crude death rate in New Zealand is 8 per 1,000. It is inconceivable for a correct death rate to be as low as 8 per 1,000, since this would imply an expectation of life of 125 years. In New Zealand, where actual mortality is lower than in any other country in the world, the mean expectation of life of the newly-born (1933) is 68 years. The correct death rate, then, is 1/68 or 14·7 per 1,000. In the case of New Zealand the crude death rate is only about half as high as the correct death rate derived from the life table. The reason for this big discrepancy is the peculiar age composition of the New Zealand population, which is mainly due to very considerable immigration in former times. The lowest correct death rate, then, is now 14·7. And it is hard to conceive how it will ever be much lower, because a correct death rate of 11 would presuppose a mean expectation of life of 90 years.

The correct death rate, on the other hand, may be very high. When 50 years ago (1881–1882) in Moscow the majority of the newly-born died in their first year of age, the correct death rate reached 61.[1]

In England, as in the whole of Western and Northern Europe, the correct death rate is 16 or 17, while the crude death rate is 12. The difference between the two rates is so large because even in Western and Northern Europe, where emigration has exceeded immigration, the age composition of the population tends to lower the number of deaths. Mortality is everywhere high among the youngest children and among the oldest persons, while it is practically negligible in the age from two or three until about 50 years. Since at present the number of young children is small (because so few children are born), and since at present the number of old persons is small (because the older generation was subject to a high mortality), the crude death rate must necessarily be low. But this low death rate cannot possibly last

[1] Computed from Académie des Sciences d'Ukraïne, Travaux de l'Institut démographique, vol. v, Ptoukha, M., *Mortalité en Russie et en Ukraïne*, p. 181.

with present mortality. The persons between 15 and 50 years, who are now so numerous, will grow older and will thereby swell those age groups where death claims most victims, while there are not sufficient children to fill up the age groups which are more or less secure against death.

3. Standardized Death Rate

The fact that the crude death rate is a most inadequate gauge for measuring the difference between the mortality of various countries or the trend of mortality is universally recognized. But the trouble involved in computing a complete life table and the ignorance or neglect of the fact that an abridged life table is only a few hours' work, and provides a death rate sufficiently accurate for any demographical study have induced many statisticians to seek another substitute for the crude death rate. The most common substitute chosen in England is the standardized death rate.

As shown on p. 133, a standardized death rate may be computed through the " direct " or through the " indirect " method. We shall not discuss here the various applications of these two methods in England and elsewhere,[1] but shall confine ourselves to presenting the method which has been used in the official English statistics since the beginning of this century. At this time " it was decided to adopt in future work, by the method of direct standardization, a standard population consisting of the population of England and Wales as enumerated at the Census of 1901, and to recalculate by reference to this standard such of the rates for

[1] A " History of Standardization " is given in *The Registrar-General's Decennial Supplement, England and Wales*, 1921, Part III, pp. xxxv–xlii, London, 1933. It is confined to England, and the reader should keep this fact in mind. A statement like : " In 1891, Dr. Ogle, to whom the direct method of standardization seems to be due . . .," should not be interpreted as meaning that this method was first proposed by Dr. Ogle (1891). It had been amply used before that, for instance, by the Statistical Office of Hamburg (see *Statistik des Hamburgischen Staats, Heft XII, II. Abtheilung*, p. 45, Hamburg, 1883). But Dr. Ogle apparently was the first Englishman to propose it.

earlier periods as might be necessary." [1] The reason for adopting the age composition found at the census of 1901 as a standard was not because this age composition was considered " normal," but because it differed considerably from the age composition found at former censuses :

> The tabulated results of the census of 1901 showed such a remarkable change in the age-constitution as to make it evident that the proportion of deaths to population in 1901 and recent previous years were not fairly comparable with those in earlier years.[2]

The standardized death rates for 1933 [3] have been found by computing (1) what would have been the death rate of the total population for this year, if mortality at various ages had been for males and for females as it was in 1933, but sex and age composition as it was in 1901 ; (2) what would have been the death rate of the male and the death rate of the female population, if mortality at various ages had been for males and females as it was in 1933, but age composition both for males and females as it was for the total population in 1901. Table 51 shows the procedure. It may seem surprising that the standardized death rates for males and for females have been computed without regard to the differences in sex composition, and it may seem preferable to compute the standardized death rate for the males by dividing col. (5) by col. (4), and col. (10) by col. (9). This method was used, indeed, exclusively until 1912. In the Registrar-General's Report for that year the tables still gave the results of the earlier method, showing a death rate of 13·8 for males and 12·1 for females.[4] But a footnote to the table said :

> The Standardized death-rates for Persons are those which would have been recorded if the sex and age constitution of the population had been the same as in 1901. Those for Males and Females are standardized for differences of age constitution in each sex, but not for differences between the two sexes. See note, p. xxxvii.

[1] *Decennial Supplement*, 1921, Part III, p. xxxvii.
[2] *Sixty-Fourth Annual Report* (1901), p. xvi.
[3] See *The Registrar-General's Statistical Review*, 1933, Tables, Part I, Civil, pp. 6–8.
[4] See *Seventy-Fifth Report* (1912), p. 20.

TABLE 51.—STANDARDIZATION OF THE

(Standard :

Years of Age	Males					
	Population [1] 1933	Deaths [2] 1933	Death rate 1933	Standard Population [3] 1901	Expected Deaths 1933 (3)×(4)	Population [1] 1933
	(1)	(2)	(3)	(4)	(5)	(6)
0–4	1,486,600	29,547	19·88	57,039	1,133·7	1,448,000
5–14	3,333,000	6,171	1·85	104,832	194·1	3,265,300
15–24	3,268,700	9,582	2·93	94,693	277·6	3,331,400
25–34	3,235,300	11,345	3·51	76,425	268·0	3,423,500
35–44	2,552,100	14,583	5·71	59,394	339·4	3,011,500
45–54	2,301,600	26,874	11·68	42,924	501·2	2,673,400
55–64	1,834,900	43,547	23·73	27,913	662·4	2,064,500
65–74	1,006,200	57,068	56·72	14,691	833·2	1,241,100
75 and up	338,600	51,908	153·30	5,632	863·4	534,300
Total . .	19,357,000	250,625	12·95	483,543	5,073·0	20,993,000

[1] See *The Registrar-General's Statistical Review*, 1933, Tables, Part I, p. 1. [2] See *ibid.*, p. 124.

TABLE 52.—STANDARDIZATION OF THE

(Standard :

Years of Age	Males					
	Population [1] 1901	Deaths [2] 1901	Death rate 1901	Standard Population [3] 1933	Expected Deaths 1901 (3)×(4)	Population [1] 1901
	(1)	(2)	(3)	(4)	(5)	(6)
0–4	1,855,361	109,581	59·06	36,843	2,176·0	1,861,347
5–14	3,409,963	10,848	3·18	82,602	262·8	3,419,068
15–24	3,080,166	12,475	4·05	81,008	328·1	3,286,899
25–34	2,485,954	15,550	6·26	80,181	501·5	2,769,886
35–44	1,931,943	20,545	10·63	63,249	672·6	2,064,062
45–54	1,396,209	25,295	18·12	57,041	1,033·4	1,505,982
55–64	907,945	30,560	33·66	45,475	1,530·6	1,035,305
65–74	477,868	32,603	68·23	24,937	1,701·3	598,138
75 and up	183,204	28,161	153·71	8,391	1,289·9	258,543
Total . .	15,728,613	285,618	18·16	479,727	9,496·2	16,799,230

[1] See *Census of England and Wales*, 1901, *General Report with Appendices*, p. 206.
[2] See *Sixty-Fourth Annual Report of the Registrar-General* (1901), p. 124.

DEATH RATES, ENGLAND, 1933.
Population, 1901.)

Females				Total		
Deaths [2] 1933	Death rate 1933	Standard Population [3] 1901	Expected Deaths 1933 (8)×(9)	Standard Population [3] 1901 (4)+(9)	Expected Deaths, 1933	
					Males (3)×(11)	Females (8)×(11)
(7)	(8)	(9)	(10)	(11)	(12)	(13)
22,920	15·83	57,223	905·8	114,262	2,271·0	1,808·6
5,638	1·73	105,112	181·5	209,944	388·7	362·5
8,710	2·61	101,049	264·2	195,742	573·8	511·8
10,983	3·21	85,154	273·2	161,579	566·6	518·4
13,958	4·63	63,455	294·1	122,849	702·0	569·4
22,274	8·33	46,298	385·7	89,222	1,041·8	743·4
35,715	17·30	31,828	550·6	59,741	1,417·8	1,033·5
54,619	44·01	18,389	809·3	33,080	1,876·2	1,455·8
71,023	132·93	7,949	1,056·6	13,581	2,082·0	1,805·3
245,840	11·71	516,457	4,721·0	1,000,000	10,919·9	8,808·7

[3] See *The Registrar-General's Decennial Supplement*, 1921, *Part III*, p. xxxvii.

DEATH RATES, ENGLAND, 1901.
Population, 1933.)

Females				Total		
Deaths [2] 1901	Death rate 1901	Standard Population [3] 1933	Expected Deaths 1901 (8)×(9)	Standard Population [3] 1933 (4)+(9)	Expected Deaths, 1901	
					Males (3)×(11)	Females (8)×(11)
(7)	(8)	(9)	(10)	(11)	(12)	(13)
92,166	49·52	35,886	1,776·9	72,729	4,295·5	3,601·2
11,143	3·26	80,924	263·7	163,526	520·2	532·9
11,618	3·53	82,563	291·8	163,571	662·5	578·2
14,767	5·33	84,845	452·3	165,026	1,032·3	879·8
18,073	8·76	74,635	653·5	137,884	1,466·3	1,207·3
20,943	13·91	66,255	921·4	123,296	2,233·7	1,714·6
27,575	26·63	51,165	1,362·8	96,640	3,252·8	2,574·0
34,003	56·85	30,758	1,748·6	55,695	3,799·8	3,166·2
35,679	138·00	13,242	1,827·4	21,633	3,325·3	2,985·4
265,967	15·83	520,273	9,298·4	1,000,000	20,588·4	17,239·6

[3] Computed from Table 51, cols. (1) and (6).

The text indeed reads as follows : [1]

The standard mortality * of males in 1912 exceeded that of females by 14 per cent . . .

From 1913 on the standardized rates for males and for females were computed exclusively through the method shown in Table 51. They exaggerate the difference between male and female mortality. It would, it seems to us, convey a better picture of this difference if the male mortality were shown to be $\frac{5073{\cdot}0}{483{,}543}=10{\cdot}5$ (instead of 10·9) per 1,000 and the female mortality $\frac{4721{\cdot}0}{516{,}457}=9{\cdot}1$ (instead of 8·8) per 1,000.

However, the standized death rate for the total population, which in 1933 was $5{\cdot}073+4{\cdot}721=9{\cdot}794$ per 1,000, shows accurately what the crude death rate in 1933 would have been if the sex and age composition had been the same as in 1901. Obviously this rate by itself is not instructive since it does not refer to actual mortality in 1933, which, if computed by relating the deaths of 1933 to the population of 1933, was 12·304, and which, if derived from the life table, appears to be 16·45. The reason why the standardized rate for 1933 appears so low is that the older age groups with their high mortality comprised in 1901 a much smaller proportion of the population than in 1933. Let us see whether the standardized rate of 1933 becomes more instructive when compared with standardized rates of earlier years. For 1901, the standardized death rate was, of course, equal to the crude death rate, namely, 16·957. The standardized death rate thus decreased from 1901 to 1933 by 42·2 per cent, while the crude death rate

[1] *Ibid.*, p. xxxvii.

* *I.e.* by the ordinary method of calculation by which the death-rates at ages for each sex are applied to the number of the sex living at each age in a standard million. But this method of comparison, while fair as between dates or localities, is inapplicable to a comparison between the sexes since it ignores the less favourable age-constitution of the female element in the standard population. To allow for this the age-group death-rates for each sex have been applied successively to the 1901 standard million of persons without distinction of sex, with the result that the male rates yield a mortality of 14,237 per million and the female rates one of 11,753. Thus the true measure of excess of male mortality is 21 per cent., and not 14.

decreased by only 27·4 per cent. But the crude death rate itself decreased more than the correct death rate derived from the life table. The standardized death rate, therefore, makes appear the reduction of mortality in the course of this century much larger still than the crude death rate.

Would the standardized death rates convey a less distorted picture of the trend of mortality if another standard were chosen ? Table 52 shows what would have been the standardized death rate for 1901 if the sex and age composition had then been what it actually was in 1933. It appears that under this assumption the standardized death rate for 1901 would have been 9·496+9·298=18·795. Since for 1933 the standardized death rate would be equal to the crude death rate, namely, 12·304, the decrease would appear to have been 34·5 per cent as against 42·2, if the age composition of 1901 is chosen as a standard. The difference from the trend shown by the crude and the correct death rate is smaller, but still very large.

The trend of the crude, the standardized, and the stationary death rates was as follows :

Period	Crude	Standardized	Stationary
1871–1880	20·49	20·3	23·28
1881–1890	18·73	18·6	22·03
1891–1900	18·19	18·1	21·78
1901–1910	15·36	15·2	19·83
1910–1912	13·77	13·4	18·73
1920–1922	12·42	11·6	17·38
1933	12·30	9·8	16·45

From 1871–1880 to 1920–1922 the crude and the standardized death rates differed very little from each other, the former decreasing by 39 per cent, the latter by about 43 per cent. But from 1920–1922 to 1933 the crude death rate decreased by only 1 per cent, while the standardized death rate decreased by 15 per cent. The death rate of the stationary population, on the other hand, decreased from 1871–1880 to 1920–1922 by only 25 per cent, and from 1920–1922 to 1933

by 5 per cent. The standardized death rate is, then, a still less adequate gauge for the measurement of mortality than the crude death rate.

It would be also a mistake to believe that standardization of death rates is useful in measuring mortality from various causes. The best method of ascertaining the relative importance of each cause of death is to subdivide the deaths by age derived from the life table according to causes of deaths.[1] The results of such a computation are shown in Table 53 for a few selected causes of deaths for England,

TABLE 53.—MALE MORTALITY ACCORDING TO LIFE TABLE BY CAUSES OF DEATHS, ENGLAND, 1933.

Years of Age	All Causes	Influenza	Tuberculosis	Cancer	Diseases of		Other
					Respiratory System	Digestive System	
0–1	70·56	1·01	0·94	0·03	13·66	8·48	46·44
1–4	25·10	1·13	2·31	0·14	7·89	2·19	11·44
5–9	10·19	0·27	1·06	0·12	1·33	0·92	6·49
10–14	6·60	0·20	0·84	0·09	0·58	0·61	4·28
15–19	11·25	0·53	2·97	0·16	0·88	0·69	6·02
20–24	14·28	0·60	5·17	0·20	1·08	0·79	6·44
25–29	14·15	0·74	4·90	0·36	1·15	0·85	6·15
30–34	15·61	1·07	4·86	0·63	1·69	1·10	6·26
35–39	19·96	1·72	5·15	1·32	2·78	1·31	7·68
40–44	26·43	2·35	5·46	2·35	3·60	1·91	10·76
45–49	37·62	3·09	5·81	4·57	5·28	3·03	15·84
50–54	49·34	3·17	5·59	7·68	6·56	3·43	22·91
55–59	65·62	3·21	4·80	12·10	7·51	4·04	33·96
60–64	84·66	3·28	3·46	17·10	8·12	4·60	48·10
65–69	112·54	3·40	2·20	21·72	9·95	4·83	70·44
70–74	135·36	4·29	1·18	21·09	12·27	4·44	92·09
75–79	138·78	5·20	0·41	16·82	13·95	3·59	98·81
80 and more	161·95	7·02	0·22	10·84	19·45	3·27	121·15
Total.	1,000·00	42·28	57·33	117·32	117·73	50·08	615·26

1933. Since, according to the male life table 929·44 out of 1,000 live-born survived the first year of age, 70·56 died from all causes in the first year of age. Since 304 of the 21,311 male deaths under one were caused by influenza, 1·01 out of 1,000 live-born died from influenza in their first year of age. The corresponding proportion of deaths from influenza at age one to four years was 1·13, and the proportion for all ages was 42·28. Out of 1,000 deaths 42·28 were thus due to

[1] See Böckh, *Die Bewegung der Bevölkerung der Stadt Berlin in den Jahren* 1869 *bis* 1878, pp. 68–71, XV–XIX, Berlin, 1884.

influenza, 57·33 to tuberculosis (all forms), etc. Table 54 shows the relative importance of the various causes of deaths computed from the total number of deaths, from the standardized death rate and from the death rate of the stationary population as well as the crude, the standardized, and the stationary death rates.

TABLE 54.—PROPORTIONS OF MALE DEATHS AND DEATH RATES BY CAUSES, ENGLAND, 1933.

Causes	Deaths	Per 1,000 Deaths			Death Rates		
		Crude	Standardized	Stationary	Crude	Standardized	Stationary
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Influenza. . .	10,926	43·6	42·4	42·3	0·564	0·463	0·718
Tuberculosis .	18,734	74·7	82·5	57·3	0·968	0·901	0·974
Cancer . . .	28,837	115·1	94·8	117·3	1·490	1·035	1·993
Diseases Respiratory System .	30,269	120·8	132·1	117·7	1·564	1·442	2·000
Diseases Digestive System .	14,004	55·9	62·6	50·1	0·723	0·684	0·851
Other . . .	147,855	589·9	585·6	615·3	7·639	6·395	10·454
Total . . .	250,625	1,000·0	1,000 0	1,000·0	12·948	10·920	16·990

Cols. (1), (5), (6), see *The Registrar-General's Statistical Review of England and Wales*, 1933, Tables, Part I, Medical, pp. 9–42.
Col. (2) computed from col. (1).
Col. (3) computed from col. (6).
Col. (4), see Table 53.
Col. (7) computed from col. 4.

The standardized death rates convey an utterly wrong picture of the importance of the various causes of deaths: the rate for tuberculosis is nearly twice as high as the rate for influenza and almost as high as the rate for cancer; the rate for cancer is nearly 30 per cent lower than the rate for diseases of the respiratory system. The correct death rate for tuberculosis is about 35 per cent higher than the rate for influenza and less than half as high as the rate for cancer; the correct rate for cancer is practically the same as that for diseases of the respiratory system. The relative importance of the various causes of deaths can be derived more accurately from the crude than from the standardized death rates.

CHAPTER VI

THE BALANCE OF BIRTHS AND DEATHS

1. Vital Index

A HUNDRED years ago the earth was inhabited by about 1,000 million people. Scores of milliards [1] of human beings had been born before that; but all with the exception of one milliard had died, and this milliard has also died since. To-day the earth is inhabited by about 2,000 million people. They are the survivors of perhaps 5,000 million children born in the course of the last hundred years, and they will, in all likelihood, also be dead 100 years hence. The upper limit of a hundred years for human life has perhaps not changed in the course of time. But the proportion of people who live more than fifty years has increased enormously. As a consequence thereof deaths lagged considerably behind births in the last hundred years, and the excess of births over deaths in that short period was about as large as in the preceding scores of thousands of years.

The difference between the number of births and deaths in a given time determines the extent of population growth or population decrease in that period. This, according to Graunt (1662), is the main reason "why the Accompts of Burials, and Christnings should be kept universally": [2]

> There seems to be good reason, why the *Magistrate* should himself take notice of the numbers of *Burials*, and *Christnings*, viz. to see, whether the City increase or decrease in people; whether it increase proportionably with the rest of the Nation; whether it be grown big enough, or too big, *&c.*[3]

He ascertained that in London "in 40 years, from the year 1603, to the year 1644, exclusive of both years, there

[1] A milliard is one thousand million.
[2] Graunt, *Natural and Political Observations*, 1st ed., Index.
[3] *Ibid.*, p. 12.

have been set down (as happening within the same ground, space, or Parishes) although differently numbered, and divided, 363,935 Burials, and but 330,747 Christnings."

From this single Observation it will follow, That *London* hath decreased in its People, the contrary whereof we see by its daily increase of Buildings upon new Foundations, and by the turning of great Palacious Houses into small Tenements. It is therefore certain, that *London* is supplied with People from out of the Countrey, whereby not onely to repair the overplus difference of *Burials* above-mentioned, but likewise to increase its *Inhabitants* according to the said increase of housing.[1]

But, if we consider what I have upon exact enquiry found true, *viz.* That in the Countrie,[2] within ninetie years, there have been 6339 *Christnings*, and but 5280 *Burials*, the increase of *London* will be salved without inferring the decrease of the People in the Countrie ; and withall, in case all *England* have but fourteen times more People than *London*, it will appear, how the said increase of the Country may increase the People, both of *London*, and it self . . .[3]

In " The Index " to Graunt's book these sections are summarized as follows :

42. *That in* London *there have been twelve Burials for eleven Christnings.*

43. *That in the* Country *there have been, contrary-wise, sixty three Christnings for fifty two Burials.*

This ratio of deaths to births or births to deaths has been computed frequently in the course of the following two centuries, especially for communities in which no census had been taken and births and deaths, therefore, could not be related to population. But such ratios tell us less about population increase than the difference between the numbers of births and deaths and they tell us nothing about the reproduction of the population. Quetelet (1869) among others has warned demographers against drawing conclusions from these ratios :

Assuming, for instance, several countries, each with 3 deaths for 4 births ; can one say that these countries are in equally happy conditions ? I am far from thinking so. Russia, in 1858, had one birth for 20·5 inhabitants, and one death for 26·6 ; which makes a

[1] *Ibid.*, pp. 41–42.
[2] That is in " a certain Parish in Hampshire " (*ibid.*, p. 63).
[3] *Ibid.*, p. 42.

ratio of about 3/4. Belgium showed the same ratio since during the years 1851 to 1860 she had on an average 33·0 deaths per year and 44·2 births. But the significance of the ratios is quite different although the mathematical values are the same : this latter science, it is true, does not see any essential difference between the two fractions $\frac{20{\cdot}5}{26{\cdot}6}$ and $\frac{33{\cdot}0}{44{\cdot}2}$, which it considers practically equal to 3/4; but the statistician takes into account the nature of the figures, and he does not mix the productive ages with the ages of childhood.[1]

It is important to know the nature of the increase of a population since the figures of the births and the deaths are insufficient without taking account of the population figure. . . . All that can be said in general is that the value of the ratio of births to deaths may remain the same under the most different conditions.[2]

Let us suppose that in a nation the ratio of births to deaths were $\frac{n}{d}$: this value would remain the same if the two terms of the fraction are multiplied by the same coefficient, for example by a : one would have $\frac{n \,.\, a}{d \,.\, a}$. Now, this value need not change numerically and yet produce results which differ greatly in the eyes of the statistician. . . .[3]

If, for instance, it happened that England yielded double the yearly number of births and that they should be set off by the double number of deaths, nothing would be changed in the ratio of increase ; but the prudent man could judge the multiplied sorrows and the considerable losses which the country would experience under such circumstances.[4]

Quetelet succeeded temporarily in abating the temptation to draw far reaching conclusions from the ratio of births to deaths. But fifty years later the well-known American biologist Raymond Pearl declared " that there is no other statistical constant which furnishes so adequate a picture as this of the net biological status of a population as a whole at any given moment." [5] Since on his authority the United States Census Bureau has computed such ratios, it seems necessary to analyse this new attempt of using the ratio of

[1] Quetelet, A., *Physique Sociale*, vol. i, p. 344, Brussels, 1869. Quetelet actually meant to say that Belgium in 1851–1860 had one birth for 33·0 inhabitants, and one death for 44·2.

[2] *Ibid.*, p. 345.

[3] *Ibid.*, pp. 346–347.

[4] *Ibid.*, p. 347.

[5] Pearl, Raymond, " The Vitality of the Peoples of America," *American Journal of Hygiene*, vol. i, p. 647, September–November, 1921.

births to deaths as a criterium for vitality. Pearl himself states : [1]

> My study of the population problem began in 1920 with an examination of the course of the vital index (birth-death ratio, 100 births/deaths) during and following the war in the chief cities and countries.

But in making this statement his memory failed him. The vital index appearing in his early writings [2] was not the ratio of 100 births to deaths, but the ratio of 100 deaths to births :

> The relation of birth-rate and death-rate changes to population changes is a simple one and may be put this way. If in a given time unit the percentage
>
> $$\frac{100 \text{ Deaths}}{\text{Births}}$$
>
> has a value less than 100, it means that the births exceed the deaths, and that the population is increasing within the specified time unit. If, on the other hand, the percentage is greater than 100, it means that the deaths are more frequent than the births, and that the population is decreasing, again within the specified time unit. The ratio expressed in (I) may be conveniently designated as the vital index of a population.[3]

He called particular attention to the fact that the preliminary vital statistic figures for France and England indicated for 1920 a very low ratio of deaths to births. " With an increase of 157 per cent in marriages in 1919 over 1918 . . . the 1920 vital index for France may well prove to be considerably below 100."

In England and Wales the provisional figure indicates that 1920 will show a lower vital index than that country has had for many years.

Altogether, these examples, which include the effects of the most

[1] *The Biology of Population Growth*, p. 3, New York, 1925.

[2] See " The Effect of the War on the Chief Factors of Population Change," *Science*, June 4, 1920, New Series, vol. 51, pp. 553–556 ; " A further Note on War and Population," *Science*, February 4, 1921, vol. 53, pp. 120–121 ; *The Biology of Death*, pp. 244–246, Philadelphia, 1922.

[3] Pearl, " The Effect of the War," *Science*, New Series, vol. 51, pp. 553–554.

destructive war known to modern man, and the most devastating epidemic since the Middle Ages, furnish a substantial demonstration of the fact that population growth is a highly self-regulated biological phenomenon. Those persons who see in war and pestilence any absolute solution of the world problem of population, as postulated by Malthus, are optimists indeed. As a matter of fact, all history definitely tells us, and recent history fairly shouts in its emphasis, that such events make the merest ephemeral flicker in the steady onward march of population growth.[1]

So much was he impressed by the 1920 ratio of deaths to births in England that he did not see that mortality was practically the same as before the War, and that the stupendous increase of marriages since the War had failed to raise fertility above the pre-war level.[2]

He realized, however, that "a lower vital index" was a strange expression for a higher vitality, and in his later writings replaced the ratio 100 Deaths to Births by the ratio 100 Births to Deaths. This ratio, he said in 1922, "measures more effectively than any other demographic function yet devised the essential biological fitness of a

[1] Pearl, "A further Note on War and Population," *Science*, New Series, vol. 53, p. 121.

[2] As late as 1930 he stated:

"The population of England and Wales is today exhibiting a greater purely biological survival value as a whole population than it was three-quarters of a century ago. Whether it is a mentally, morally or anthropometrically fitter population does not now concern us. We are dealing here solely with the fact that, taking the people of England and Wales as a whole, slightly over two babies were born for every death per year in 1920, as against 1·4 babies per death per year in 1838–1839.

Now this result will strike any one informed as to the sociological and eugenical literature of the last two decades as curiously at variance with the pessimistic tenor of that literature, taken as a whole. It has been pronounced from high places that the general trend of British people was biologically downwards, that they were in fact becoming a decadent race. Abundant quotations in support of this contention could be cited, were space available and were it necessary. This gloomy view has had its foundation mainly upon the fact that, since the quinquennium 1875–1880, the birth rate in England and Wales has been falling rather rapidly . . .

But from a purely numerical viewpoint, what matters a falling birth rate if the death rate falls even more rapidly, so that the net survivorship at any instant of time is constantly getting higher?"

(Pearl, Raymond, "Some Aspects of the Biology of Human Populations," *Human Biology and Racial Welfare*, ed. by Edmund V. Cowdry, p. 531, London, 1930, Reprinted in *Collected Papers from The Institute for Biological Research of The Johns Hopkins University*, vol. iv, Baltimore, 1930.)

population, in the sense of organic evolution." [1] In 1923 he summarized his views as follows : [2]

The writer has elsewhere suggested that the term " vital index " be used to designate that measure of a population's condition which is given by the ratio of births to deaths within a given time. It may fairly be said that there is no other statistical constant which furnishes so adequate a picture as this of the net biologic status of a population as a whole at any given moment. If the ratio 100 Births/Deaths is greater than 100, the population is in a growing and in so far healthy condition. If it is less than 100, the population is *biologically* unhealthy. Depopulation may not be actually occurring if there is a sufficient amount of immigration to make up the deficiency in births. But fundamentally and innately the condition is not a sound one from a biologic standpoint, though under certain circumstances it may be from a social standpoint. It is curious, in view of the obvious significance of this constant, the vital index of a population, that so little attention is paid to it by demographers. After much study of it I am convinced that no single figure gives so sensitive a measure of the vitality of a nation or any subgroup of people as this does. There appears to have been no adequate general discussion of it since that of Wernicke * in 1889, and even he does not use it in the most effective manner or form. Sundbärg † proposed its use as a " measure of civilization " of different peoples. Rubin ‡ criticized Sundbärg, but only in respect of technic, proposing as a measure of civilization D^2/B in place of D/B, where D=deaths and B=births. Recently Pell § has dealt with the idea implicit in the birth/death ratio, but in a most inadequate manner.

As to the authorities here quoted by Pearl it should be said : Wernicke computed the ratio of births to deaths only for the sixteenth, seventeenth and eighteenth centuries, for which he had no adequate census data. For the nineteenth century

[1] Pearl, Raymond, and Burger, Magdalen H., " The Vital Index of the Population of England and Wales, 1838–1920," *Proceedings of the National Academy of Sciences of the United States of America*, vol. 8, 1922, p. 71.

[2] Pearl, Raymond, *Introduction to Medical Biometry and Statistics*, pp. 168–169, Philadelphia and London, 1923.

* Wernicke, J.: Das Verhältniss zwischen Geborenen und Gestorbenen in historischer Entwicklung und für die Gegenwart in Stadt und Land, Jena, 1889, vi, and 91 pp. 8vo.

† Sundbärg, G.: Dodstalen sassom Kulturmätare, Nationalökonomiska Föreningens Forhandlingar, i, Aaret, 1895, Stockholm, 1896.

‡ Rubin, M.: " A Measure of Civilization," *Jour. Roy. Stat. Soc.*, vol. 60, pp. 148–161, 1897.

§ Pell, C. E.: The Law of Births and Deaths, London (Unwin), 1921, 192 pp.

he did not compute such ratios, and at no place of his book does he indicate that he considers them to be a means of measuring the vitality of a population.

The mention of Sundbärg and Rubin is still less to the point. Sundbärg, following the example of D'Ivernois,[1] proposed to use the *death rate* as a measure for culture.

> Every rational human activity has, as its innermost purpose, the struggle *for* life, *against* disorganisation and death. But it is just these rational activities of mankind which we comprehend in the term *civilisation*. Thus the figures of mortality must, in truth, be also a measure of how far civilisation has been able to repel the forces of death. It is not implied by this, that the mortality returns may be employed, for this purpose, in a purely mechanical fashion, so that, with the mere figures, one might be able, without more ado, to read off by how much per cent. one country's civilisation stood higher than that of another. If we would ascertain the meaning of the figures of mortality, it is necessary, not only to study these on their own account for the different places and times, but also the whole circumstances, so far as we can procure information about them. It is, however, my conviction that the result of this will, in the end, be that the mortality returns will prove an excellent *guiding thread* to a comprehensive estimate ; in truth, the best which can be found.[2]

Rubin did not criticize Sundbärg " only in respect of technic " ; their disagreement was fundamental.

> However, I do not quite agree with Hr. Sundbärg in his fundamental view, and it is to this disagreement and the emendation I wish to propose, that this article will be devoted.
>
> Let us even suppose it were perfectly true that the greatness or smallness of the figures of mortality is an evidence of the strength with which, by the conscious and unconscious co-operation of community and individual, we contrive to keep back death, it is, after all, but a *maintaining*, not a *creating* strength. But, no more than the human race itself, can civilisation continue without renewal. The two most

[1] See D'Ivernois, Sir Francis, *Sur la mortalité proportionelle des peuples, considéreé comme mesure de leur aisance et de leur civilisation*, Geneva, 1833. See also D'Ivernois, *Sur la fécondité et la mortalité proportionelles des peuples considérées comme mesures de leur aisance et de leur civilisation*, p. 1, Geneva, 1836 : " That the increasing or decreasing proportion of their mortality is the least uncertain sign of the conditions of the masses and their respective civilisations."

[2] Quoted from the translation given in Rubin, Marcus, " A Measure of Civilisation," *Journal of the Royal Statistical Society*, vol. lx, 1897, pp. 148–149. Sundbärg and Rubin used the word " kultur " instead of civilization.

active instincts in all living things are those of self-preservation and reproduction, both alike necessary for the conservation of life and of the human race. Smallness of the figures of mortality is an expression of the triumph of self-preservation, but this must not be purchased at the cost of the increase of the race, which finds its expression in the *figures of natality*. The way in which the human race regulates the figures of natality is the reverse of the medal, and it cannot be omitted in a complete estimate of " civilisation." [1]

The bulk of Rubin's paper is devoted to the proof that " the birth-rate must only be used as a corrective in connection with the death-rate where the question is that of the standard of civilisation." But since we are not concerned here with the measurement of civilization—either through D or through D/B or through D^2/B or through the per head consumption of soap or through any other symbol—we shall not enter into a discussion of Rubin's argument.[2]

Pell likewise did not at all deal " with the idea implicit in the birth/death ratio," and never computed this ratio. Like Muret and other writers of the eighteenth century, he found that " in human society birthrate and deathrate rise and fall together with remarkable regularity," [3] and came to the conclusion " That the decline in the birthrate is mainly due to a natural law which adjusts the degree of fertility to suit the deathrate of the race." [4]

Pearl himself computed the ratios deaths/births or births/deaths on a very large scale. He thus calculated such ratios for England for each quarter from 1838 to 1920 and for each state of the United States Birth Registration Area, 1915–1920, distinguishing native whites, foreign-born whites, and negroes, as well as rural and urban districts. He computed in many cases also " age-specific vital indices." The Bureau of the Census in a similar manner computed " age specific vital

[1] *Ibid.*, p. 149.

[2] It may be mentioned incidentally, that Sundbärg replied that the advantage gained by the introduction of B into the index is problematical, and that on this ground he claimed the use of the death rate, pure and simple, as an index of civilization as most satisfactory (see *ibid.*, p. 161).

[3] Pell, Charles Edward, *The Law of Births and Deaths, being a Study of the Variation in the Degree of Animal Fertility under the Influence of the Environment*, p. 43, London, 1921.

[4] *Ibid.*, p. 190.

indices for native and foreign-born white women " for each registration state in 1920–1922. The Bureau commented on them as follows : [1]

The following vital indices have been computed by the method described by Doctor Pearl in his " Medical Biometry and Statistics," pages 168 to 175. For example, the vital index for native white women aged 20 to 24=

$$\frac{\text{Births to native white women aged 20–24 (100)}}{\text{Deaths of native white women aged 20–24}}.$$

Owing to great differences in the age distribution of native white women as compared with foreign-born white women, the vital indices for the broad age group 15 to 44 are much less valuable for comparisons of the native with the foreign-born than are the vital indices for the 5-year age groups. The following are a few of the interesting 1922 figures which appear in this table :

For native white women aged 15 to 44, the three highest indices are for Utah (3100), Nebraska (3014), and Virginia (2898·7), and the three lowest are for California (1378·7), Massachusetts (1424·7) and New York (1592·9).

Native white women aged 20–24 have a vital index of 3630·6, while foreign-born white women of the same age have a vital index of 4795·3. For native white women of this age the lowest vital index (2592·3) appears for Massachusetts and the highest (5808·6) for Nebraska. For foreign-born white women of this age comparatively high indices appear, for example, for Pennsylvania (6697·4) and for Connecticut (5822·2). Similar differences throughout the table emphasize once more the fact that foreign-born white women as a class have more children than native white women. The vital indices available for Negroes are much lower than those for native white women.

It is hard to see from what standpoint these figures should be " interesting." Who could be interested in the information that " the vital indices available for Negroes are much lower than those for native white women," since the reproduction of the negroes was actually not lower than that of the native whites ? [2]

The attempts to measure the balance of births and deaths

[1] *Birth, Stillbirth, and Infant Mortality Statistics for the Birth Registration Area of the United States*, 1922, p. 17, Washington, 1924.

[2] See, for instance, Whelpton, P. K., " Population, Trends in Differentials of True Increase and Age Composition," *American Journal of Sociology*, vol. xxxv, 1930, p. 872.

by computing the ratio of births to deaths form a striking example of the many futile methods which in course of time have been used for this purpose. Reproduction cannot be measured by the exclusive use of vital statistics or of census data, and it cannot be measured by combining vital statistics with census data, without taking into account fertility and mortality at the various ages.

2. Net Reproduction Rate

Raymond Pearl (1922), in referring to the decline of the birth rate in England, says: "But from a purely biological view-point, what matters a falling birth rate if the death rate falls even more rapidly, so that the net survivorship at any instant of time is constantly getting higher?" [1] Like many others, then, Pearl did not realize that, however low may be the number of deaths, there must be a definite and rather considerable number of births in order to insure the reproduction of the population. Even if Isaiah's vision became true that "the child shall die an hundred years old," it would still be necessary that on the average each woman have two children who in turn become parents of two children, etc., if the population were not sooner or later to decrease.

Let us consider conditions in Western and Northern Europe. Ninety years ago births exceeded deaths by 1,000,000. In the first decade of this century the average yearly excess had risen to over 1,600,000. By 1933 it had dropped to 600,000. No one will deny that the excess of births has shrunk considerably, but many people believe that after all an annual increase of 600,000 proves that reproduction is still ample.

As a matter of fact, births still keep up amply with deaths even in Western and Northern Europe. But this does not imply that the reproduction of the people of Western and Northern Europe is still ample. If the newly-born were merely to replace the dead, it would only be necessary for births to equal deaths, and if no death occurred, no birth would be needed. This consideration in itself shows that

[1] Pearl and Burger, "The Vital Increase of the Population of England and Wales," p. 75.

something must be wrong with the usual comparison of births and deaths. If in a given population no death occurred and no birth, such a population would continually grow older, and after 50 years there would be no more women of child-bearing age and no more men with full physical working capacity. The total population would still be as large as 50 years earlier, but in the meanwhile it would have done nothing towards its reproduction, and it would have lost any future chance of reproduction.

A comparison of yearly births and yearly deaths is not sufficient to allow a judgment upon vitality. If in a given country the number of aged persons is small and the number of persons in the best years of life is large, this country may have a low death rate and a high birth rate even if mortality in each age group is large and if fertility is small. The possibly large excess of births over deaths in such a country may give the impression of a vitality still high while perhaps fertility in fact is no longer sufficient to enable the population to hold its own. In spite of the still large excess of births over deaths, mortality and fertility may already be such that if they do not change this population is doomed to die out.

The pertinent question is not: Is there an excess of births over deaths? but rather: Are fertility and mortality such that a generation which would be permanently subject to them would, during its lifetime, that is, until it has died out, produce sufficient children to replace it? If, for instance, 1,000 newly-born produce in the course of their lives exactly 1,000 children, the population after the death of the older 1,000 will remain unaltered. If fertility and mortality continue to be what they were, the 1,000 children will in the course of their lives again produce 1,000 children, and if fertility and mortality remain permanently the same, the population will always exactly hold its own. If more than 1,000 children are produced by a generation of 1,000 newly-born, the population will increase; if less than 1,000 are produced, the population will decrease and finally die out.

Since we are concerned here with births only, it suffices to take into account the female population. The pertinent

question then is: Are fertility and mortality such that 1,000 newly-born girls during the course of their lives give birth to 1,000 girls? If it is so the first generation of 1,000 females will at its death have been fully replaced by the girls they have borne, and the population will remain constant; otherwise it will in the long run increase or decrease.

The best method for ascertaining how many girls, with fertility and mortality as they are, would be born to 1,000 newly-born girls, consists in computing a fertility table, *i.e.* in multiplying the annual fertility rates by the annual numbers of females in the stationary population and adding the products.

The first fertility table was calculated in 1884 by Richard Böckh.[1] He took the life table of the city of Berlin for 1879, multiplied the number of females of each year of age by the fertility rate of that year of age in 1879, and added the products so obtained. The sum, 2,172, gave him the number of births to 1,000 females on the basis of the fertility and mortality of 1879. Since according to the distribution of the sexes at birth there were 1,053 male births per 1,000 female births, he concluded that the real natural increase of the Berlin population in 1879 was $\frac{2,172}{2,053} - 1 = 6$ per cent.[2]

Whenever the births by age of mothers are also classified by sex the detour used by Böckh is not necessary. The annual fertility rates computed by relating the female births to the living females can then directly be multiplied by the annual numbers of females in the stationary population. Table 55 shows the procedure for Australia, 1920–1922. Let us take

[1] See *Statistisches Jahrbuch der Stadt Berlin*, 1884, pp. 30–34.

[2] Böckh calculated five similar fertility tables for 1886–1890; the author of this book computed five such tables for 1891–1895, and Hirschberg computed five tables for 1896–1900 (see *Statistisches Jahrbuch der Stadt Berlin*, 1893, p. 36; 1897, p. 57; 1899, pp. 101–104; 1900–1902, pp. 82–83). A table for Sweden, 1891–1900, was computed by the author in 1907, while Rahts (1912), computed tables for a group of German states in 1881–1890, 1891–1900, 1901–1910; for Sweden in 1816–1840, 1841–1855, 1891–1900; for Denmark in 1895–1900, and for France in 1898–1903 (see *Statistik des Deutschen Reichs*, vol. 246, pp. 18*–19*). Outside of Germany the first fertility table seems to have been computed in 1925 by Dublin and Lotka (see *Journal of the American Statistical Association*, September, 1925, vol. xx, p. 309). Since 1927 many tables have been published both in Europe and America.

as an example the age of 24 years. The yearly number of female births per 1,000 females is 80. If out of 1,000 live-

TABLE 55.—FERTILITY TABLE, AUSTRALIA, 1920–1922.

Years of Age	Female Births per 1,000 Females	Females in Stationary Population	Female Births in Stationary Population
13	0·058	909·26	0·053
14	0·241	908·12	0·219
15	0·809	906·87	0·734
16	3·169	905·48	2·869
17	8·913	903·90	8·056
18	18·810	902·11	16·968
19	34·729	900·11	31·260
20	42·100	897·93	37·803
21	54·898	895·59	49·166
22	69·787	893·12	62·328
23	78·243	890·51	69·676
24	80·072	887·79	71·087
25	82·713	884·95	73·197
26	85·782	882·00	75·660
27	82·555	878·93	72·560
28	82·477	875·76	72·230
29	81·816	872·51	71·385
30	76·933	869·18	66·868
31	73·952	865·77	64·025
32	67·958	862·32	58·602
33	65·877	858·78	56·444
34	62·958	855·14	53·838
35	58·736	851·38	50·007
36	53·014	847·46	44·927
37	50·162	843·40	42·307
38	46·882	839·21	39·344
39	40·996	834·95	34·230
40	31·294	830·61	25·993
41	24·495	826·22	20·239
42	21·911	821·79	18·006
43	15·316	817·26	12·518
44	9·351	812·60	7·599
45	5·412	807·79	4·372
46	2·713	802·76	2·177
47	1·429	797·51	1·140
48	0·564	791·97	0·446
49	0·201	786·13	0·158
50	0·037	779·96	0·029
Total .	1,517·363	———	1,318·520

born females none died before the age of 25, 1,000 live-born females would at the age of 24 bear 80 girls. But since out of 1,000 live-born females only 888 are found to be living at the

age of 24—or to put it otherwise : since, according to the life table, 1,000 live-born females do not live 1,000, but 888 years between the age of 24 and 25 years—1,000 live-born females, at the age of 24, bear 71 girls only. The sum of the net rates of the individual years is 1,318·5. Total fertility (measured by female births) is thus reduced by mortality from 1,517·4 to 1,318·5. While 1,000 women passing through child-bearing age would, according to the fertility of 1920–1922, give birth to 1,517 girls, 1,000 newly-born girls would, according to the fertility *and mortality* of 1920–1922, give birth to 1,319 girls. A thousand mothers thus would give birth to 1,319 future mothers ; and 1·319 would represent the *net reproduction rate.*

Since the births according to age of mothers are seldom at the same time classified according to sex, it is necessary, as a rule, to resort to the detour used by Böckh. In order, therefore, to facilitate comparison, we show in Table 57 the quinquennial results of fertility tables for all countries concerned on the basis of total births instead of female births. The stationary female population (or the years lived) in child-bearing age is given in Table 56, while the quinquennial fertility rates are to be found in Table 37. A summary of the net reproduction rates, similar to the summary of gross reproduction rates (Table 38), is given in Table 58.

The net reproduction rate, of course, must always be smaller than the gross reproduction rate. Both rates could only be equal if all newly-born girls reached child-bearing age and passed through child-bearing age. Table 59 shows how many out of 1,000 newly-born girls enter child-bearing age and how many live through the child-bearing period. It will be seen, for instance, that in England, according to the mortality of 1838–1854, 697 out of 1,000 newly-born girls entered child-bearing age and 473 passed through child-bearing age, while for 1933 the corresponding figures are 907 and 788. The last column of this table shows the average number of years lived in child-bearing age by the newly-born girls. If none of them died before 50 years of age they would all live 35 years in child-bearing age. The average number of years lived in child-bearing age must, therefore, always be lower

TABLE 56.—YEARS LIVED BY 1,000 LIVE-BORN FEMALES IN CHILD-BEARING AGE BY QUINQUENNIAL AGE GROUPS, 1871–1933.

Period	15–19 Years	20–24 Years	25–29 Years	30–34 Years	35–39 Years	40–44 Years	45–49 Years	Total
1. WESTERN AND NORTHERN EUROPE								
Denmark								
1885–1894	3,736·16	3,632·78	3,523·78	3,403·84	3,275·76	3,134·48	2,990·16	23,696·96
1885–1900	3,970·54	3,882·07	3,784·96	3,676·57	3,558·63	3,433·20	3,293·86	25,599·83
1901–1905	4,154·92	4,070·88	3,977·33	3,873·72	3,760·28	3,635·11	3,496·72	26,968·96
1906–1910	4,245·89	4,167·99	4,078·09	3,979·79	3,873·39	3,755·41	3,621·60	27,722·16
1911–1915	4,324·91	4,252·01	4,169·40	4,076·73	3,973·30	3,857·41	3,726·88	28,380·64
1916–1920	4,324·63	4,225·36	4,104·95	3,975·83	3,849·78	3,723·46	3,588·40	27,792·41
1921–1925	4,461·09	4,399·63	4,330·15	4,254·58	4,168·10	4,066·20	3,939·96	29,619·71
1926–1930	4,496·78	4,440·15	4,374·37	4,305·65	4,222·59	4,121·99	4,004·03	29,965·56
England								
1933	4,507	4,449	4,383	4,313	4,233	4,136	4,013	30,034
France								
1898–1903	3,814·97	3,700·89	3,569·86	3,436·48	3,299·30	3,157·03	3,003·16	23,981·69
1908–1913	4,035·67	3,930·73	3,810·38	3,685·55	3,557·43	3,419·83	3,267·06	25,706·65
1920–1923	4,220·27	4,114·24	3,995·30	3,875·57	3,755·03	3,629·64	3,486·11	27,076·16
1925–1927	4,296	4,191	4,076	3,963	3,851	3,728	3,586	27,691
Germany								
Whole Country								
1881–1890	3,230·09	3,146·51	3,039·51	2,913·74	2,774·90	2,629·64	2,483·30	20,217·69
1891–1900	3,445·48	3,368·41	3,272·35	3,161·75	3,038·69	2,905·81	2,765·45	21,957·94
1901–1910	3,713·01	3,637·00	3,543·12	3,439·10	3,324·85	3,200·40	3,065·75	23,923·23
1924–1926	4,319·90	4,253·12	4,172·00	4,086·49	3,995·14	3,891·79	3,769·14	28,487·58
1929	4,374	4,317	4,244	4,164	4,076	3,976	3,851	29,002
1931	4,482	4,431	4,368	4,297	4,218	4,126	4,009	29,931
Prussia								
1930–1932	4,466	4,415	4,353	4,282	4,204	4,114	3,999	29,833
Saxony								
1924–1926	4,406·60	4,346·44	4,271·81	4,195·75	4,115·19	4,019·07	3,898·95	29,253·81
Norway								
1871–1880	3,900·57	3,791·97	3,665·89	3,528·24	3,381·02	3,226·62	3,073·65	24,567·96
1881–1890	3,857·96	3,746·27	3,619·00	3,480·45	3,334·10	3,188·23	3,042·91	24,268·92
1901–1910	4,282·27	4,156·81	4,021·29	3,884·04	3,743·17	3,601·37	3,457·93	27,146·88
1911–1920	4,372·75	4,235·93	4,083·65	3,938·42	3,801·97	3,663·77	3,521·20	27,617·69
Sweden								
1871–1880	3,706·67	3,615·96	3,507·37	3,387·17	3,259·18	3,120·15	2,977·27	23,573·77
1881–1890	3,848·74	3,755·34	3,649·32	3,535·06	3,413·26	3,281·05	3,143·49	24,626·26
1891–1900	3,999·67	3,895·72	3,780·52	3,662·68	3,539·48	3,407·96	3,271·62	25,557·65
1901–1910	4,204·70	4,096·81	3,979·46	3,861·01	3,739·23	3,610·92	3,474·96	26,967·09
1911–1915	4,346·85	4,242·25	4,128·36	4,016·54	3,899·18	3,772·13	3,636·52	28,041·83
1916–1920	4,321·08	4,182·92	4,029·99	3,880·25	3,740·61	3,606·43	3,469·38	27,230·66
1921–1925	4,518·00	4,430·79	4,335·83	4,243·25	4,145·77	4,037·51	3,914·67	29,625·82
1926–1930	4,545·28	4,463·25	4,372·04	4,280·80	4,188·46	4,086·47	3,964·85	29,891·15
2. EASTERN AND SOUTHERN EUROPE								
Austria								
1895–1900	3,162	3,056	2,935	2,808	2,674	2,531	2,388	19,554
1901–1905	3,321·35	3,207·32	3,082·27	2,951·51	2,813·74	2,670·52	2,522·94	20,569·65
1906–1910	3,435·48	3,325·33	3,202·02	3,074·12	2,940·76	2,800·19	2,650·66	21,428·56
1913	3,564	3,465	3,350	3,228	3,101	2,965	2,819	22,492
1928	4,229	4,158	4,073	3,985	3,893	3,787	3,655	27,780
1931–1932	4,303	4,237	4,161	4,078	3,989	3,886	3,760	28,414

TABLE 56.—YEARS LIVED BY 1,000 LIVE-BORN FEMALES IN CHILD-BEARING AGE BY QUINQUENNIAL AGE GROUPS, 1871–1933—*continued.*

Period	15–19 Years	20–24 Years	25–29 Years	30–34 Years	35–39 Years	40–44 Years	45–49 Years	Total
				Bulgaria				
1901–1905	3,341·39	3,188·72	3,018·55	2,846·66	2,680·74	2,520·03	2,363·79	19,959·88
1906–1910	3,227	3,076	2,905	2,741	2,585	2,436	2,295	19,265
1921–1926	3,417	3,285	3,318	2,999	2,868	2,742	2,621	21,070
1926–1927	3,588	3,463	3,323	3,192	3,063	2,936	2,811	22,376
				Estonia				
1922–1923	3,895	3,801	3,704	3,619	3,510	3,426	3,304	25,259
				Finland				
1881–1890	3,450·27	3,348·74	3,236·81	3,116·87	2,985·64	2,847·15	2,706·29	21,691·77
1901–1910	3,696·02	3,582·57	3,464·22	3,339·77	3,211·94	3,075·70	2,940·73	23,310·95
1911–1920	3,827·32	3,692·89	3,551·07	3,411·80	3,271·73	3,132·39	2,984·00	23,871·20
1921–1930	4,172·79	4,050·09	3,922·62	3,798·24	3,676·50	3,544·24	3,401·88	26,566·36
				Hungary				
1900–1901	3,107·6	2,969·8	2,828·4	2,694·1	2,556·0	2,414·7	2,269·3	18,839·9
1920–1921	3,372·00	3,244·35	3,113·05	2,986·51	2,866·86	2,743·47	2,613·64	20,939·88
1930–1931	3,905	3,801	3,689	3,583	3,478	3,367	3,241	25,064
				Italy				
1931	4,872 [1]	3,189 [2]	3,910	3,822	3,732	3,632	3,518	26,675
				Latvia				
1929	4,365	4,325	4,277	4,225	4,170	4,113	4,046	29,521
				Portugal				
1930–1931	3,828	3,741	3,642	3,540	3,433	3,321	3,205	24,710
				Russia				
				50 Provinces of Europe				
1896–1897	2,670·9	2,584·2	2,485·6	2,380·8	2,266·9	2,144·4	2,007·1	16,539·9
				Ukraine				
1896–1897	3,011·55	2,903·20	2,785·44	2,665·34	2,536·82	2,397·97	2,236·84	18,537·16
1926–1927	3,631·58	3,536·04	3,430·60	3,325·37	3,215·58	3,100·70	2,977·30	23,217·17
				Serbia				
1900–1901	4,018 [1]	2,532 [2]	2,993	2,802	2,611	2,419	2,230	19,605
				3. OTHER COUNTRIES				
				Canada (excluding Yukon and North West Territories)				
1931	4,425	4,365	4,290	4,205	4,112	4,012	3,898	29,307
				Australia [3]				
1920–1922	4,518·47	4,464·94	4,394·15	4,311·19	4,216·40	4,108·48	3,986·16	29,999·79
1932–1933	4,696	4,655	4,600	4,537	4,464	4,377	4,266	31,595
				New Zealand [3]				
1911–1915	4,588·73	4,534·85	4,464·57	4,378·29	4,274·11	4,155·67	4,014·82	30,411·04
1921–1922	4,649·42	4,595·12	4,525·00	4,445·93	4,360·18	4,261·71	4,139·73	30,977·09
1933	4,767	4,727	4,675	4,616	4,548	4,465	4,368	32,166

[1] 15–20 years. [2] 21–24 years. [3] Excluding Aborigines.

TABLE 57.—BIRTHS PER 1,000 WOMEN IN STATIONARY POPULATION, 1871–1933.

Period	15–19 Years	20–24 Years	25–29 Years	30–34 Years	35–39 Years	40–44 Years	45–49 Years	Total	Net Reproduction Rate
1. WESTERN AND NORTHERN EUROPE									
Denmark [1]									
1885–1894	57·90	481·89	823·57	765·10	600·70	282·22	27·41	3,038·79	1·463
1895–1900	68·70	544·78	848·22	768·18	604·92	270·90	27·03	3,132·73	1·509
1901–1905	83·60	582·56	895·99	767·59	564·05	243·05	25·63	3,162·47	1·524
1906–1910	103·99	618·36	849·10	726·71	524·89	228·53	21·28	3,072·86	1·486
1911–1915	103·37	585·08	783·01	657·98	475·21	209·07	20·50	2,834·22	1·372
1916–1920	95·57	543·38	712·21	588·82	410·00	177·98	16·51	2,544 47	1 228
1921–1925	106·90	533·24	696·68	551·76	387·85	165·47	16·30	2,458·20	1·186
1926–1930	102·83	478·32	586·29	474·18	310·20	128·75	12·58	2,093·15	1·012
England									
1933	78	328	399	341	237	108	13	1,504	0·735
France									
1898–1903 [2]	106·27	522·46	606·44	441·86	286·33	112·68	17·15	2,093·19	0·979
1908–1913 [2]	114·74	547·69	571·79	402·02	251·90	93·02	8·85	1,990·01	0·930
1920–1923	101·30	540·75	612·67	415·28	240·59	87·54	7·99	2,006·12	0·977
1925–1927	117	544	547	391	217	77	7	1,900	0·929
Germany									
Whole Country									
1881–1890	64·63	593·92	898·55	739·59	538·38	224·66	27·04	3,086·77	1·448
1891–1900	74·87	647·36	948·68	769·47	532·08	212·93	23·86	3,209·25	1·512
1901–1910	90·30	668·82	965·14	712·93	479·57	197·12	20·53	3,134·41	1·480
1924–1926	81·87	475·63	588·52	425·11	241·67	88·32	7·47	1,908·59	0·924
1929	79	414	501	370	225	88	10	1,687	0·818
1931	93	384	457	329	198	75	7	1,543	0·748
Prussia									
1930–1932	88	393	481	348	209	82	9	1,610	0·755
Saxony									
1924–1926	83·83	427·36	471·49	323·88	181·87	64·20	4·74	1,557·37	0·757
Norway									
1871–1880	25·97	378·95	761·69	833·73	700·57	423·75	100·96	3,225·62	1·571
1881–1890	28·09	376·29	745·72	797·10	676·34	405·65	89·25	3,118·44	1·513
1901–1910	47·57	439·33	810·66	784·99	661·32	387·32	69·82	3,201·01	1·556
1911–1920	46·37	431·22	704·83	693·68	570·78	308·33	55·40	2,810·61	1·365
Sweden [1]									
1871–1880	35·44	384·86	731·50	790·07	664·59	372·56	55·26	3,034·28	1·454
1881–1890	40·45	399·08	729·49	784·23	658·15	363·90	52·53	3,027·83	1·455
1891–1900	54·56	442·09	733·75	752·65	622·46	337·56	44·04	2,987·11	1·435
1901–1910	75·18	497·96	755·63	727·78	577·93	302·17	36·69	2,973·34	1·429
1911–1915	84·68	480·76	674·06	635·82	508·35	261·18	29·51	2,674·36	1·288
1916–1920	73·22	441·10	599·14	543·30	415·22	211·83	25·39	2,309·20	1·111
1921–1925	80·96	430·75	573·11	510·51	387·58	194·46	23·74	2,201·11	1·058
1926–1930	81·13	370·47	464·79	406·44	296·75	143·21	16·92	1,779·71	0·857
2. EASTERN AND SOUTHERN EUROPE									
Austria									
1895–1900	90	553	778	731	487	223	42	2,904	1·411
1901–1905	90·96	565·72	801·70	723·85	483·03	227·10	42·90	2,935·26	1·428
1906–1910	97·58	575·92	784·21	703·71	471·23	224·99	42·59	2,900·23	1·410
1913	91	543	732	645	434	203	39	2,687	1·305
1928	106	391	429	351	232	87	17	1,613	0·782
1931–1932	117	371	392	312	199	71	14	1,476	0·714

TABLE 57.—BIRTHS PER 1,000 WOMEN IN STATIONARY POPULATION, 1871–1933—*continued.*

Period	15–19 Years	20–24 Years	25–29 Years	30–34 Years	35–39 Years	40–44 Years	45–49 Years	Total	Net Reproduction Rate
				Bulgaria					
1901–1905	78·54	920·13	942·50	880·82	547·68	305·00	131·27	3,805·94	1·839
1906–1910	76	897	893	795	547	302	129	3,639	1·760
1921–1926	120	810	856	626	445	216	94	3,167	1·534
1926–1927	130	781	806	603	403	188	86	2,997	1·446
				Estonia					
1922–1923	37	341	513	438	312	143	21	1,805	0·877
				Finland [1]					
1881–1890	65·69	514·57	757·97	746·71	604·69	345·19	52·00	3,086·82	1·485
1901–1910	59·97	496·32	734·15	721·52	593·69	325·99	46·94	2,978·58	1·433
1911–1920	55·78	430·95	595·40	565·00	465·63	269·43	39·13	2,421·32	1·161
1921–1930	59·23	436·79	586·57	508·55	396·32	218·79	32·72	2,238·97	1·074
				Hungary					
1900–1901	176·53	769·09	791·80	621·03	412·43	167·34	31·45	2,969·67	1·445
1920–1921	146·95	672·52	639·97	441·62	296·76	115·92	22·09	2,335·83	1·127
1930–1931	163	616	575	405	276	91	18	2,144	1·011
				Italy					
1931	144 [3]	442 [4]	673	583	425	189	22	2,478	1·209
				Latvia [2]					
1929	43	358	539	468	323	122	24	1,877	0·900
				Portugal					
1930–1931	90	566	726	617	490	218	38	2,745	1·334
				Russia					
				50 Provinces of Europe					
1896–1897	80	799	831	789	496	278	119	3,392	1·65
				Ukraine					
1896–1897	96	953	990	938	590	330	141	4,038	1·96
1926–1927	155·49	839·70	887·68	743·68	506·08	256·01	73·09	3,461·73	1·676
				Serbia					
1900–1901	327 [3]	701 [4]	1,092	680	358	141	23	3,322	1·613
				3. OTHER COUNTRIES					
				Canada (excluding Yukon and North West Territories)					
1931	133	599	751	611	424	176	21	2,715	1·319
				Australia [5]					
1920–1922	124·31	599·04	751·70	617·07	431·47	172·99	16·92	2,713·50	1·318
1932–1933	120	483	583	430	268	111	12	2,007	0·976
				New Zealand [5]					
1911–1915	95·99	545·82	793·19	686·67	461·06	186·57	21·56	2,790·86	1·357
1921–1922	79·66	563·10	768·45	633·51	417·29	164·70	18·87	2,645·58	1·291
1933	80	448	610	463	281	104	12	1,998	0·978

[1] Confinements. [2] Live- and still-born. [3] 15–20 years.
[4] 21–24 years. [5] Excluding Aborigines.

TABLE 58.—NET REPRODUCTION RATES, 1871–1933.

Years	Denmark	France	Germany	Norway	Sweden	Austria	Bulgaria	Finland	Hungary	Ukraine	Australia	New Zealand
1871–1880	—	—	—	1·571	1·454	—	—	—	—	—	—	—
1881–1884	—	—	(1·448)	1·513	1·455	—	—	1·485	—	—	—	—
1885–1890	1·463	—				—	—		—	—	—	—
1891–1894		—		—		—	—	—	—	—	—	—
1895		—		—			—	—	—	—	—	—
1896–1897	1·509	—	(1·512)	—	1·435	1·411	—	—	—	(1·96)	—	—
1898–1899				—			—	—	—	—	—	—
1900		0·979		—			—	—	1·445	—	—	—
1901										—	—	—
1902–1903	1·524		(1·480)	1·556	1·429	1·428	1·839	1·433	—	—	—	—
1904–1905		—							—	—	—	—
1906–1907	1·486	—				1·410	1·760		—	—	—	—
1908–1910									—	—	—	—
1911–1912		0·930	—		1·288	—	—	1·161	—	—	—	1·357
1913	1·372		—			1·305	—		—	—	—	
1914–1915		—	—	1·365		—	—		—	—	—	—
1916–1919	1·228	—	—		1·111	—	—		—	—	—	—
1920			—			—	—		1·127	—	1·318	
1921		0·977	—	—		—				—		1·291
1922			—	—		—			—	—	—	—
1923	1·186		—	—	1·058	—	1·534		—	—	—	—
1924		—		—		—			—	—	—	—
1925			(0·924)	—		—		1·074	—	—	—	—
1926		0·929		—		—			—	1·676	—	—
1927			—	—		—	1·446 [1]		—		—	—
1928	1·012	—	—	—	0·857	0·782	—		—	—	—	—
1929		—	(0·818)	—		—	—		—	—	—	—
1930		—	—	—		—	—		1·011	—	—	—
1931	—	—	(0·748)	—	—	0·714	—	—		—	—	—
1932	—	—	—	—	—		—	—	—	—	(0·976)	—
1933	(0·91)	(0·82)	(0·70)	—	(0·73)	(0·67)	(1·3)	(0·9)	(0·9)	—		(0·978)

[1] 1926–1927.

than 35 years. It was as low as 16·54 in European Russia in 1896–1897, while it exceeded 30 in England, 1933; Holland, 1921–1930; Australia, 1932–1933; New Zealand, 1921–1922 and 1933. The average number for all Western and Northern Europe in 1933 was nearly 30.

What is the range of the net reproduction rate? The highest net reproduction rate ascertained for any large country was for the Ukraine in 1896–1897. It amounted to 1·96, which means almost a doubling within a generation. Fifty years ago the net reproduction rate in Germany, Denmark, and Sweden was 1·4 or 1·5. This means a doubling of the population within two generations. Conditions were more or less the same in the other countries of Western and Northern Europe with the exception of France and Ireland, where the net reproduction rate was about one; the population there merely held its own. In 1926 the net reproduction rate was less than one in France and in Sweden, and especially in England and Germany. For the whole of Western and Northern Europe it was about 0·93. By 1933 it had dropped to about 0·76. It was lower still in England, Sweden, and Germany. In Saxony it was about 0·5.

The net reproduction rate shows how many future mothers will be born to present mothers according to present fertility and mortality. It is the best gauge for measuring the balance of births and deaths. Such net reproduction rates have been computed in recent years by the central statistical offices of Poland,[1] Germany,[2] and Sweden,[3] and by the Registrar-General for England and Wales.[4]

[1] See Szulc, Stefan, "Les mesures de l'acroissement naturel," *Revue Trimestrielle de Statistique de la République Polonaise*, 1930, vol. vii, pp. 1–16.

[2] See *Statistik des Deutschen Reichs*, vol. 360, pp. 48–53; *ibid.*, vol. 393, pp. 31–32; vol. 401, pp. 669–673; vol. 423, pp. 30–31.

[3] See Sveriges Officiella Statistik, *Befolkningsrörelsen*, 1924–1925, pp. 67*–68*; *ibid.*, 1926, pp. 25*–26*; 1927, pp. 22*–23*; 1928, pp. 36*–37*; 1929, pp. 26*–27*; 1930, pp. 31*–32*; 1931, pp. 31*–32*.

[4] See *The Registrar-General's Statistical Review of England and Wales for the Year* 1926, Text, pp. 157–159. See also *ibid.*, 1927, Text, pp. 133–134; 1928, Text, p. 178; 1929, Text, p. 130; 1930, Text, p. 132; 1931, Text, p. 134. The official English net reproduction rates are not as accurate as those for Germany, Poland, and Sweden, because the fertility rates had to be estimated and because the stationary population was not derived from a life table.

TABLE 59.—FEMALE SURVIVORS AND YEARS LIVED IN CHILD-BEARING AGE.

Years	Females Surviving (Out of 1,000 Live-born)		Years Lived between 15 and 50 Years
	15 Years	50 Years	
1. WESTERN AND NORTHERN EUROPE			
Belgium			
1841–1850	670	446	19·68
1856	681	415	19·41
1881–1890	744	559	23·08
1891–1900	762	592	24·01
Denmark			
1840–1849	705	507	21·56
1845–1849	691	498	21·11
1860–1869	722	532	22·17
1870–1879	753	557	23·14
1880–1889	759	577	23·59
1885–1894	758	583	23·70
1895–1900	802	644	25·60
1901–1905	839	684	26·97
1906–1910	856	710	27·72
1911–1915	871	730	28·38
1916–1920	872	703	27·79
1921–1925	897	773	29·62
1926–1930	904	786	29·97
England and Wales			
1838–1854	697	473	20·77
1871–1880	725	521	22·31
1881–1890	759	564	23·74
1891–1900	755	580	23·99
1901–1910	799	647	25·90
1910–1912	828	689	27·08
1920–1922	871	742	28·61
1933	907	788	30·03
Scotland			
1871	698	469	20·68
1891–1900	766	564	23·73
1910–1912	818	652	26·22
1920–1922	848	696	27·44
1930–1932	875	744	28·76
Northern Ireland			
1925–1927	867	683	27·52
Irish Free State			
1925–1927	880	703	28·11

TABLE 59.—FEMALE SURVIVORS AND YEARS LIVED IN CHILD-BEARING AGE —*continued.*

Years	Females Surviving (Out of 1,000 Live-born)		Years Lived between 15 and 50 Years
	15 Years	50 Years	
1. WESTERN AND NORTHERN EUROPE—*continued.*			
France			
1840–1859	676	477	20·27
1861–1865	660	474	19·93
1877–1881	703	507	21·36
1898–1903	772	584	23·98
1908–1913	816	636	25·71
1920–1923	853	681	27·08
1925–1927	868	702	27·69
Germany			
1871/72–1880/81	639	452	19·48
1881–1890	653	481	20·22
1891–1900	696	538	21·96
1910–1910	749	598	23·92
1910–1911	779	632	25·07
1924–1926	869	739	28·49
1929	880	756	29·00
1931	901	788	29·93
Holland			
1840–1851	644	424	19·04
1850–1859	650	431	19·22
1860–1869	651	441	19·43
1870–1879	668	468	20·14
1880–1889	712	531	22·08
1890–1899	759	591	24·00
1900–1909	803	657	25·90
1910–1920	851	702	26·49
1921–1930	913	797	30·31
Norway			
1856–1865	769	585	24·00
1871/72–1880/81	790	599	24·57
1881/82–1890/91	782	594	24·27
1891/92–1900/01	822	631	25·59
1901/02–1910/11	867	677	27·15
1911/12–1920/21	886	689	27·62
1921/22–1930/31	924	771	29·80
Sweden			
1816–1840	719	513	22·08
1841–1845	748	559	23·35
1846–1850	734	549	22·92
1851–1855	726	531	22·52
1856–1860	705	523	21·89
1861–1870	727	558	22·88

TABLE 59.—FEMALE SURVIVORS AND YEARS LIVED IN CHILD-BEARING AGE —*continued.*

Years	Females Surviving (Out of 1,000 Live-born)		Years Lived between 15 and 50 Years
	15 Years	50 Years	
1. WESTERN AND NORTHERN EUROPE—*continued.*			
Sweden—continued.			
1871–1880	749	580	23·57
1881–1890	778	614	24·63
1891–1900	809	640	25·56
1901–1910	851	680	26·97
1911–1915	878	713	28·04
1916–1920	876	680	27·23
1921–1925	911	769	29·63
1926–1930	916	779	29·89
Switzerland			
1876/77–1880/81	721	515	21·96
1881–1888	755	549	23·18
1889–1900	786	592	24·48
1901–1910	827	644	26·05
1920–1921	879	720	28·37
2. EASTERN AND SOUTHERN EUROPE.			
Austria			
1866–1875	579	371	17·95
1870–1880	578	384	17·16
1895–1900	641	462	19·55
1900–1901	658	475	20·11
1901–1905	674	489	20·57
1906–1910	697	514	21·43
1913	722	549	22·49
1928	852	716	27·78
1931–1932	867	738	28·41
Bulgaria			
1900–1905	682	457	19·96
1906–1910	658	445	19·26
1921–1926	695	512	21·07
1926–1927	728	549	22·38
Estonia			
1922–1923	788	651	25·26
Finland			
1881–1890	699	526	21·69
1901–1910	751	574	23·31
1911–1920	778	580	23·87
1921–1925	836	667	26·38
1921–1930	846	665	26·57

TABLE 59.—FEMALE SURVIVORS AND YEARS LIVED IN CHILD-BEARING AGE —*continued.*

Years	Females Surviving (Out of 1,000 Live-born)		Years Lived between 15 and 50 Years
	15 Years	50 Years	
2. EASTERN AND SOUTHERN EUROPE—*continued.*			
Hungary			
1900–1901	633	440	18·84
1920–1921	685	509	20·94
1930–1931	790	635	25·06
Italy			
1876–1887	588	409	17·66
1899–1902	686	520	21·26
1901–1910	701	537	21·80
1910–1912	744	582	23·35
1921–1922	775	624	24·63
1930–1932	822	693	26·80
Latvia			
1929	877	802	29·52
Poland			
Provinces of Poznań and Pomorze			
1921	742	578	23·36
1922	769	617	24·54
1923	777	632	24·95
1924	790	648	25·43
1925	793	660	25·72
1926	773	635	24·85
Portugal			
1930–1931	773	629	24·71
Russia			
50 Provinces of Europe			
1896–1897	542	387	16·54
Baltic Provinces			
1896–1897	678	545	21·6
Ukraine			
1896–1897	612	430	18·54
1926–1927	734	583	23·22
Serbia			
1900–1901	690	429	19·61

TABLE 59.—FEMALE SURVIVORS AND YEARS LIVED IN CHILD-BEARING AGE —*continued.*

Years	Females Surviving (Out of 1,000 Live-born)		Years Lived between 15 and 50 Years
	15 Years	50 Years	
3. OTHER COUNTRIES.			
United States of America			
11 Original Registration States, Total			
1900–1902	803	604	25·03
1909–1911	828	650	26·38
Massachusetts, Total			
1889–1890	723	506	21·81
1893–1897	749	540	22·90
1900–1902	780	593	24·49
1909–1911	822	651	26·35
Canada (excluding Yukon and North West Territories)			
1931	890	767	29·31
Australia (excluding Aborigines)			
1881–1890	807	600	25·12
1891–1900	838	661	26·71
1901–1910	876	719	28·40
1920–1922	908	783	30·00
1932–1933	942	840	31·60
New Zealand (excluding Aborigines)			
1891–1895	871	704	27·95
1896–1900	889	733	28·82
1901–1905	892	744	29·06
1906–1910	903	761	29·52
1911–1915	922	787	30·41
1921–1922	934	813	30·98
1933	956	863	32·17

3. NET REPRODUCTION RATE OF MARRIED WOMEN

We have shown in Chapter IV, section 7, how separate gross reproduction rates may be computed for women who never marry and for women who marry. The corresponding net reproduction rates can be found by reducing the " years lived in single state " and the " years lived after first wedding " according to mortality as shown by the life table. In order to

obtain accurate results it would be necessary to compute separate life tables (1) for single women, and (2) for married, widowed, and divorced women. This is, of course, feasible. But mortality in child-bearing age is nowadays so low that approximately correct results will be obtained by applying a life table for the total female population to each of the two groups. Table 60 shows the procedure for Denmark, 1926–1930.

TABLE 60.—NET REPRODUCTION RATES, DENMARK, 1926–1930.

Years of Age	Fertility Rates [1]		Years Lived by 1,000 Females			Girls Born to 1,000 Females		
	Illeg. (1)	Leg. (2)	Total [2] (3)	in single state [3] (4)	after first wedding [3] (5)	Illeg. (6)	Leg. (7)	Total (8)
15–19	6·2	284·6	4,497	4,410	87	27·3	24·6	51·9
20–24	13·6	149·9	4,440	3,164	1,276	42·9	191·4	234·3
25–29	10·0	99·8	4,374	1,649	2,725	16·4	272·0	288·4
30–34	7·8	67·8	4,306	1,043	3,263	8·1	221·2	229·3
35–39	5·7	42·6	4,223	829	3,394	4·7	144·7	149·4
40–44	2·3	17·3	4,122	729	3,393	1·7	58·7	60·4
45–49	0·2	1·6	4,004	667	3,337	0·2	5·4	5·6
Total	—	—	29,966	12,491	17,475	101·3	918·0	1,019·3

The net reproduction rate computed on the basis of fertility, mortality, and nuptiality of 1926–1930 is 1·019. Of the 1,019 girls borne by 1,000 females, 918 are legitimate, and 101 are illegitimate children. Since according to the nuptiality table 837 out of 1,000 females reaching the age of 50 years had married (while 163 had remained single) the net reproduction rate of women who married (once or oftener), if measured by legitimate births only, was $\frac{0{\cdot}918}{0{\cdot}837} = 1{\cdot}097$.[4]

How do gross and net reproduction rates of women who marry once or more compare with the refined ratios of births to

[1] See Table 46.
[2] See Table 56.
[3] Col. (3) × Table 46, cols. (5) and (6).
[4] By including the illegitimate girls borne, either before, or during, or after marriage, by women who had married (see p. 159), the net reproduction rate of women who married would rise to 1·175.

marriages proposed by Gini ? [1] The reproduction rates have first of all two points in their favour :

(1) In computing the reproduction rates the legitimate births are related to the women marrying for the first time. By relating the legitimate births to all marriages, the picture is obscured. If, for instance, in two countries each woman in the course of her life gives birth to four children, the country with the lower proportion of remarriages will in Gini's computations appear as having the more fertile women. (Gini cannot follow another procedure since he knows only the year in which the present marriage was concluded, but not the year of the first marriage of the mother.)

(2) In computing the reproduction rates the disturbing influences of migrations are automatically discarded since the births are related to the existing marriages (wives living at present in the country). The births covered by the births/marriages ratio include births to mothers who married in another country ; the marriages include marriages of brides who bear children in another country.

But there still remains the decisive question : Would the births/marriages ratios be an adequate measure either of fertility or of net reproduction if the defects just mentioned were remedied, *i.e.* would a " corrected " births/marriages ratio which would take account only of first marriages and which would discard the disturbing influences of migrations be as instructive as the reproduction rates ? In order to answer this question it is necessary to examine how mortality is dealt with in the various computations.

The legitimate gross reproduction rate assumes that of 1,000 live-born girls (N_1) who marry none dies before having passed through child-bearing age, and it shows how many legitimate girls (N_2) under this assumption would be born to N_1. The legitimate net reproduction rate assumes that 1,000 live-born girls (N_3) who later would marry are subject to present mortality, and it shows how many legitimate girls (N_4) under this assumption would be born to N_3. The treatment of mortality, then, is perfectly clear. In computing the

[1] See pp. 61–63.

gross rate mortality is excluded altogether; in computing the net rate mortality is taken account of fully. The " corrected " births/marriages ratio holds an intermediate position between gross and net reproduction. It excludes mortality before the first marriages but takes account of mortality after the first wedding. This in itself, to be sure, is unobjectionable. It would also be possible to compute a corresponding reproduction rate which may be called nuptio-reproduction rate. Such a nuptio-reproduction rate assumes that 1,000 live-born girls (N_3) who later would marry all survive their first wedding and are subject to present mortality after their first wedding, and it shows how many legitimate girls (N_4) under these assumptions are born to N_3. In order to crystallize the difference between the " corrected " births/marriages ratio and the nuptio-reproduction rate, it will be best to choose a concrete example :

The nuptio-reproduction rate for 1930 assumes that those females living in 1930 who, according to the nuptiality of 1930 (first-marriage rates by age), would not remain single, had been subject to the mortality of 1930 after their first wedding, and it shows how many girls would be born to them under these assumptions and with fertility of 1930 (fertility rates by age). The " corrected " births/marriages ratio for 1930 accepts that the women who actually married for the first time in the period 1905–1930, after their first wedding were subject to the actual mortality of 1905–1930, and it shows how many children were actually born to them in 1930. It is obvious, therefore, that even the " corrected " births/marriages ratio does not convey a clear-cut picture either of the gross reproduction corresponding to present fertility or of the net reproduction corresponding to present fertility and mortality.

4. Stable Population

The net reproduction rate shows the balance of births and deaths in a population whose age composition is that of the stationary population, that is, of the population constantly subject to the mortality indicated by the life table. Is it possible likewise to measure the balance of births and deaths

for a population constantly subject to the mortality indicated by the life table and also constantly subject to the fertility indicated by present fertility rates? This is possible, of course, only if such a population ultimately should become *stable*, that is, if it should acquire a stable age composition. The problem then arises: Will a population constantly subject to the same fertility and the same mortality ultimately become stable?

The mathematical elements of this problem have for a long time attracted the attention of both European and American mathematicians. They have come to the conclusion that a population with a constant fertility and mortality will in fact ultimately become stable. A comparatively easy approach to the computations necessary for ascertaining the age composition and the birth and death rates of the stable population is to be found in the report presented by Bortkiewicz to the 1911 congress of the International Statistical Institute.[1] He starts from the stationary population according to the German life table for 1891–1900 and shows what will be the ultimate age composition, that is, the age composition of the stable population, if the population increases every year by 7, 14, 21 or 28 per 1,000.[2] The formulas which he uses for the first two years of age are rather complicated.[3] It will suffice to quote the more simple formula for the ages from two years on:

$$\sigma_x = (1+r)^{-(x+\frac{1}{2})} \times s_x$$

in which the several symbols have the following meaning:

σ_x indicates the number of persons x to $x+1$ years old in the stable population;

r is the yearly increase;

s_x is the number of persons x to $x+1$ years old in the stationary population.

[1] Bortkiewicz, L. von, "Die Sterbeziffer und der Frauenüberschuss in der Stationären und in der Progressiven Bevölkerung, zugleich ein Beitrag zur Frage der Berechnung der 'Verlebten Zeit'," *Bulletin de l'institut international de statistique*, 1911, vol. xix, Part II, pp. 63–138.

[2] The yearly rate of increase which is identical with the difference of the birth rate and the death rate would be in those cases 6·98, 13·90, 20·78 or 27·62 per 1,000.

[3] See Bortkiewicz, p. 106.

If, then, the number of females between 20 and 21 years in the stationary population is 68,046, he finds as the number indicating the 20 to 21 year old females in the stable population increasing by 28 per 1,000 :

$$38{,}631 = 1{\cdot}028^{-20{\cdot}5} \times 68{,}046$$

His tables for the female sex thus read as follows : [1]

Years of Age	With a Yearly Increase of Population per 1,000				
	0	7	14	21	28
..	..	..	..	..	..
..	..	..	..	..	..
..	..	..	..	..	..
20	68,046	58,979	51,171	44,440	38,631
..	..	..	..	..	..
..	..	..	..	..	..
..	..	..	..	..	..
Total .	4,396,263	3,520,093	2,882,494	2,409,388	2,051,297

Since the stationary female population with 100,000 yearly female births and 100,000 yearly female deaths numbers 4,396,263, the average expectation of life is 43·96 years, the death rate $\frac{1{,}000}{43{\cdot}96} = 22{\cdot}75$, and the birth rate, of course, also 22·75. The birth rate of the stable population can be immediately derived from the totals above. In case of an increase of 7 per 1,000 it is $\frac{1{,}000}{35{\cdot}2} = 28{\cdot}41$, etc. The death rate can then be derived from the birth rate. Since with a yearly increase of 7 the yearly rate of increase is 6·98, the death rate is $28{\cdot}41 - 6{\cdot}98 = 21{\cdot}43$. The various birth and death rates are as follows : [2]

Yearly Increase per 1,000	Yearly Rate of Increase per 1,000	Birth Rate per 1,000	Death Rate per 1,000
0	—	22·75	22·75
7	6·98	28·41	21·43
14	13·90	34·69	20·79
21	20·78	41·50	20·72
28	27·62	48·75	21·13

[1] See *ibid.*, pp. 133–136.

[2] See *ibid.*, p. 108.

Bortkiewicz had come to the conclusion that a population constantly subject to the same mortality and with a constant rate of increase must ultimately become stable, that is to say, have a stable age composition, a stable birth rate, and a stable death rate. He had also shown what will be that stable age composition and how the stable birth and death rates may be derived from that stable age composition. But since one of his assumptions, the stable rate of increase, was not and could not be based on the actual conditions presented by some specific statistical example, his findings, interesting as they were from a theoretical standpoint, did not attract the attention of demographers.

The attention of demographers was indeed only aroused when 14 years later the American mathematician, Lotka, who for a long time had studied the theoretical problems of the stable population, published in collaboration with Dublin, the well-known article " On the True Rate of Natural Increase as Exemplified by the Population of the United States, 1920." [1] Unlike Bortkiewicz, who had started from a given mortality (Germany, 1891–1900) and a fictitious stable rate of increase, they started from a given mortality and a given fertility (United States, 1920), and their object was to find the stable rate of increase corresponding to that mortality and fertility. Their approach is highly mathematical, and we shall confine ourselves here [2] to showing how through Lotka's formulæ the yearly stable rate of increase (r) [3] may be derived from the net reproduction rate. If

[1] *Journal of the American Statistical Association*, September, 1925, vol. xx, pp. 305–339.

[2] For further details, see *Fertility and Reproduction*, pp. 21–35, 41–92. The bibliography there given may be supplemented here as follows :

Wicksell, S. D., " Nuptiality, Fertility and Reproduction," *Skandinavisk Aktuarietidskrift*, 1931, pp. 125–157.

Landsberg, Otto, " Die Messung des natürlichen Wachstums der Bevölkerung," *Allgemeines Statistisches Archiv.*, vol. 23, pp. 93–98, Jena, 1933.

Rich, C. D., " The Measurement of the Rate of Population Growth," *Journal of the Institute of Actuaries*, vol. lxv, Part I, pp. 38–77, London, 1934.

Wicksell, S. D., " Bidrag till den formella befolkningsteorien," *Statsøkonomisk Tidskrift*, 1934, pp. 1–94.

[3] It should be noted that Lotka designates by r the yearly rate of increase (difference between birth rate and death rate), while Bortkiewicz designates

R_0=net reproduction rate

R_1=sum of terms constituting R_0 multiplied by years of age at confinement

R_2=sum of terms constituting R_1 multiplied by years of age at confinement

$$r = \frac{\frac{R_1}{R_0} - \sqrt{\left(\frac{R_1}{R_0}\right)^2 - 2\left[\frac{R_2}{R_0} - \left(\frac{R_1}{R_0}\right)^2\right]\log_e R_0}}{\frac{R_2}{R_0} - \left(\frac{R_1}{R_0}\right)^2}$$

An approximate value of r can be found by the following formula :

$$r = \sqrt[\frac{R_1}{R_0}]{R_0} - 1$$

The mean length of a generation (T) within which the stable population increases by the proportion indicated by the net reproduction rate can best be obtained through the formula :

$$T = \frac{\log R_0}{\log (1+i)}$$

The net reproduction rate indicates by what percentage a population constantly subject to a certain fertility and a certain mortality will ultimately increase or decrease within a generation. We have shown how the ultimate yearly rate of increase or decrease may be derived from the net reproduction rate, how the age composition of the stable population may be computed, and how the ultimate yearly birth and death rates may be derived from this age composition. We shall now briefly consider the results of such a computation for England.

With a crude birth rate of 14·4 and a crude death rate of 12·3, the yearly rate of natural increase in 1933 was 2·1. If the net reproduction rate were 1, and if fertility and mortality remained constant, the population of England would ultimately have the age composition of a stationary population corre-

by r the yearly increase computed from the status at the beginning of the year. If we call this yearly increase i

$$r = \frac{\log (1+i)}{\log e}$$

sponding to the life table for 1933, with a birth rate and a death rate of 16·45 each and no natural increase. But the net reproduction rate of England in 1933 was 0·734.[1] This means that if fertility and mortality remain constant, the population will ultimately decrease by 26·6 per cent within each generation, or by 10·3 per 1,000 per year. The ultimate birth and death rates derived from the age composition of the stable population are 11·1 and 21·4 respectively. If, then, fertility and mortality should remain constant, the birth rate will decrease from 14·4 to 11·1, and the death rate will increase from 12·3 to 21·4.

The results thus obtained show the present and the ultimate condition of population growth and decrease. But they tell us very little about the changes due in the near future. Unfortunately there is no formula which might be used for computing the development till the population has become stable. This development can only be ascertained through a special computation based on fertility and mortality rates by age. Such a computation has been carried out recently for England by Dr. Enid Charles. It appears that if fertility and mortality should remain what they were in 1933, the population of England, which in 1933 was 40,350,000, would increase by about 550,000 more and would reach its peak in 1943, when the birth and death rates would be 13·85 and 13·84 respectively. From then on it would decrease constantly. In 1953 it would drop to the level of 1933 with a birth rate of 12·84 and a death rate of 15·45. By the year 2000 the population would be reduced to 29,270,000, or by 27·5 per cent as compared with 1933. The birth and the death rate would be 11·1 and 21·4 respectively, that is to say, they would correspond to the birth and death rates of the stable population. It would thus take two-thirds of a century until the stable population would be reached approximately, and the population in this period would decrease by only 27·5 per cent. But from then on the population would decrease by 26·6 per cent every generation, *i.e.* every 30 years.

[1] For the changes in fertility and mortality necessary to raise a net reproduction rate to 1, see Sauvy, Alfred, " Sur les taux de stabilisation d'une population," *Journal de la Société de Statistique de Paris*, vol. 75, 1934, pp. 51–56.

APPENDIX

TABLE I.—MEAN POPULATION

1. *Western and Northern*

Years	Belgium	Denmark	Faroe Islands, Iceland	England and Wales	Scotland	Northern Ireland	Irish Free State	Islands in the British Seas	France (1)	France (2)
1841–45	4,194	1,329	66	16,333	2,683	8,246		129	34,680	35,273
1846–50	4,355	1,397	67	17,358	2,822	7,617		138	35,514	36,128
1851–55	4,528	1,475	71	18,405	2,938	6,230		143	36,026	36,661
1856–60	4,614	1,571	75	19,472	3,026	5,893		143	36,368	37,025
1861–65	4,862	1,670	77	20,629	3,127	5,703		144	37,700	
1866–70	4,949	1,759	79	21,952	3,276	5,469		144	38,294	
1871–75	5,225	1,839	81	23,413	3,441	5,335		144	36,364	37,910
1876–80	5,445	1,937	83	25,038	3,629	5,263		142	37,156	38,709
1881–85	5,687	2,033	84	26,630	3,799	5,037		143	37,860	39,426
1886–90	5,994	2,142	84	28,140	3,944	4,808		146	38,306	39,892
1891–95	6,235	2,231	87	29,765	4,122	4,614		149	38,394	40,016
1896–00	6,610	2,370	91	31,522	4,345	4,512		150	38,744	40,427
1901–05	6,937	2,518	95	33,297	4,536	4,421		150	39,114	40,884
1906–10	7,337	2,669	99	35,063	4,680	4,389		149	39,375	41,221
1911–14	7,564	2,818	105	36,501	4,742	1,245	3,112	149	39,726	41,626
1915–19	7,543	2,971	111	37,423	4,802	1,217	3,074	150	38,040	39,550
1920	7,433	3,242	115	37,596	4,864	1,258	3,103	150	39,000	
1921	7,502	3,285	116	37,887	4,882	1,258	3,096	151	39,240	
1922	7,564	3,322	118	38,158	4,898	1,269	3,022	150	39,420	
1923	7,623	3,356	119	38,403	4,888	1,259	3,014	149	39,880	
1924	7,692	3,389	120	38,746	4,862	1,258	3,005	148	40,310	
1925	7,761	3,425	122	38,890	4,867	1,257	2,985	147	40,610	
1926	7,822	3,452	124	39,067	4,864	1,254	2,969	146	40,870	
1927	7,879	3,475	126	39,290	4,853	1,251	2,957	146	40,940	
1928	7,939	3,497	128	39,482	4,848	1,250	2,949	145	41,050	
1929	8,000	3,518	130	39,607	4,832	1,246	2,946	144	41,230	
1930	8,059	3,542	132	39,806	4,828	1,244	2,946	143	41,610	
1931	8,126	3,570	134	39,988	4,843	1,251	2,957	142	41,860	
1932	8,186	3,597	135	40,201	4,883	1,262	2,974	143	41,840	
1933	8,231	3,623	137	40,350	4,912	1,272	2,992	143	41,880	

All data—with the exception of France (2), 1841–1860, 1871–1919, Germany (2), 1841–1933, and Total (2), refer to the present territory, but those for Germany (2), 1841–1910, are slightly too high as they include the at by summing up all columns, except France (1) and Germany (1), and adding for 1911–1914 and 1915–1919

2. *Other Countries,*

Years	Austria (1)	Austria (2)	Bulgaria	Czecho-slovakia	Danzig	Estonia	Finland	Hungary (1)	Hungary (2)	Italy
1871–75	20,946	4,646	—	—	—	—	1,845	15,317	—	27,133[1]
1876–80	21,730	4,857	—	—	—	—	1,986	15,430	—	27,879
1881–85	22,530	5,075	—	—	—	—	2,132	16,104	—	28,779
1886–90	23,408	5,303	3,201[4]	—	—	—	2,295	17,041	—	29,825
1891–95	24,354	5,563	3,345	—	—	—	2,449	17,816	—	30,876
1896–00	25,465	5,856	3,604	—	—	—	2,622	18,744	—	31,926
1901–05	26,769	6,164	3,888	12,924	—	—	2,804	19,665	—	32,856
1906–10	27,943[5]	6,485[5]	4,185	13,359	—	—	3,006	20,437	—	33,824
1911–14	28,880[5]	6,720[5]	4,307	13,743	—	—	3,193	21,229	7,782	35,248
1915–19	—	6,420[7]	4,624	13,528[7]	—	—	3,320	21,310[8]	7,917	36,424
1920	—	6,455	4,825	13,592	351	—	3,349	—	7,940	—
1921	—	6,504	4,897	13,664	354	—	3,384	—	8,029	37,709
1922	—	6,528	4,998	13,796	357	1,102	3,420	—	8,103	38,197
1923	—	6,549	5,101	13,935	365	1,111	3,455	—	8,173	38,504
1924	—	6,583	5,206	14,074	374	1,116	3,485	—	8,232	38,784
1925	—	6,622	5,314	14,197	378	1,117	3,515	—	8,299	39,112
1926	—	6,652	5,423	14,312	380	1,117	3,547	—	8,383	39,462
1927	—	6,671	5,514	14,409	382	1,116	3,576	—	8,454	39,815
1928	—	6,687	5,593	14,500	386	1,116	3,604	—	8,520	40,197
1929	—	6,700	5,672	14,589	397	1,116	3,631	—	8,583	40,549
1930	—	6,713	5,751	14,682	399	1,116	3,655	—	8,649	40,888
1931	—	6,727	5,831	14,786	403	1,118	3,682	—	8,716	41,254
1932	—	6,736	5,912	14,886	406	1,122	3,709	—	8,763	41,624
1933	—	6,743	5,997	14,977	407	1,124	3,730	—	8,812	42,011

All data—with the exception of Austria (2), 1871–1913, Czechoslovakia, 1901–1914, and Hungary (2), 1911– refer to the present territory. The data for Australia and New Zealand do not include the Aborigines.

[1] 1872–1875 only. [2] 1873–1875 only. [3] 1878–1880 only. [4] 1888–1890 only. [5] 1911–1913 only.

(IN THOUSANDS).

Europe, 1841–1933.

Germany		Holland	Luxemburg	Norway	Sweden	Switzerland	Total	Years
(1)	(2)						(2)	
32,097	29,474	2,972	180	1,286	3,224	2,285	107,674	1841–45
33,356	30,633	3,058	187	1,364	3,389	2,361	110,874	1846–50
34,377	31,538	3,175	190	1,442	3,558	2,429	112,783	1851–55
35,331	32,417	3,285	193	1,546	3,727	2,484	115,471	1856–60
37,193	34,091	3,432	199	1,649	3,993	2,549	119,825	1861–65
38,683	35,462	3,586	200	1,722	4,166	2,630	123,688	1866–70
41,641	36,805	3,702	202	1,771	4,274	2,715	126,857	1871–75
44,104	39,067	3,949	207	1,876	4,500	2,803	132,648	1876–80
46,039	40,974	4,198	211	1,927	4,605	2,874	137,628	1881–85
48,176	42,929	4,466	212	1,977	4,742	2,929	142,405	1886–90
50,825	45,544	4,706	217	2,043	4,832	3,039	147,600	1891–95
54,405	48,805	5,026	230	2,172	5,032	3,226	154,518	1896–00
58,612	52,798	5,387	243	2,285	5,214	3,429	162,194	1901–05
62,863	56,680	5,778	253	2,349	5,406	3,647	169,720	1906–10
66,568	59,996	6,106	262	2,436	5,601	3,839	176,329	1911–14
66,535	60,629	6,583	263	2,550	5,770	3,880	176,741	1915–19
61,104	60,679	6,820	261	2,635	5,876	3,877	176,909	1920
61,771	61,328	6,921	261	2,668	5,929	3,876	178,400	1921
61,185	61,898	7,032	262	2,695	5,971	3,874	179,653	1922
61,577	62,304	7,150	263	2,714	5,997	3,883	181,002	1923
61,952	62,691	7,264	266	2,730	6,021	3,896	182,398	1924
62,409	63,157	7,366	268	2,748	6,045	3,910	183,558	1925
62,866	63,626	7,472	270	2,764	6,064	3,932	184,696	1926
63,252	64,022	7,576	278	2,776	6,081	3,956	185,606	1927
63,618	64,397	7,678	287	2,785	6,097	3,988	186,520	1928
63,958	64,746	7,781	292	2,796	6,113	4,022	187,403	1929
64,294	65,092	7,884	297	2,808	6,131	4,051	188,573	1930
64,630	65,441	7,999	300	2,822	6,152	4,081	189,666	1931
64,911	65,731	8,122	301	2,837	6,176	4,104	190,492	1932
65,229	66,055	8,227	302	2,851	6,201	4,125	191,301	1933

1841–1919—refer to the territory of the respective period. The data for France (2), Germany (2), and Total (2), small territories ceded to Belgium and Denmark through the Treaty of Versailles. Column Total was arrived 227,000 and 225,000 respectively for the small territories ceded to Belgium and Denmark.

1871–1933.

Latvia	Lithuania	Poland	Portugal	Rumania	Russia (Europe)	Spain	Yugoslavia	Australia	New Zealand	Years
—	—	—	—	4,363[2]	67,106	—	1,336	1,772	299	1871–75
—	—	—	—	4,466	72,102	16,768[3]	1,508	2,062	427	1876–80
—	—	—	—	4,740	76,769	17,137	1,833	2,454	531	1881–85
—	—	—	—	5,146	82,774	17,593	2,051	2,927	603	1886–90
—	—	—	—	5,465	88,450	17,996	2,231	3,331	661	1891–95
—	—	—	—	5,833	95,178	18,402	2,399	3,636	735	1896–00
—	—	—	—	6,254	103,610	18,936	2,599	3,895	822	1901–05
—	—	—	—	6,727	112,613	19,607	2,804	4,205	945	1906–10
—	—	—	6,022[6]	7,295	120,861	20,232	—	4,728	1,053	1911–14
—	2,131	26,473[7]	6,094	7,834[9]	—	20,877	11,745[7]	5,021	1,109	1915–19
—	2,103	26,746	6,023	15,514	—	21,291	11,879	5,359	1,193	1920
—	2,106	27,159	6,060	15,657	—	21,421	12,069	5,459	1,224	1921
1,815	2,136	27,839	6,116	15,900	—	21,580	12,260	5,571	1,252	1922
1,829	2,161	28,379	6,170	16,137	—	21,711	12,443	5,694	1,275	1923
1,836	2,190	28,812	6,226	16,375	—	21,865	12,631	5,814	1,299	1924
1,851	2,217	29,385	6,295	16,616	111,330	22,047	12,825	5,941	1,330	1925
1,864	2,245	29,922	6,366	16,906	113,284	22,209	13,034	6,060	1,353	1926
1,877	2,273	30,295	6,429	17,178	116,509	22,367	13,233	6,185	1,374	1927
1,889	2,301	30,697	6,493	17,419	119,075	22,523	13,408	6,304	1,391	1928
1,898	2,328	31,084	6,560	17,667	121,455	22,681	13,573	6,395	1,407	1929
1,905	2,354	31,472	6,627	17,918	—	22,851	13,767	6,467	1,425	1930
1,915	2,380	31,930	6,707	18,166	—	23,298	13,983	6,527	1,445	1931
1,926	2,407	32,407	6,796	18,426	—	23,834	14,180	6,579	1,456	1932
1,935	2,436	32,831	6,882	18,652	—	24,127	—	6,631	1,467	1933

1918—refer to the territory of the respective period. All data for Austria (2), Czechoslovakia, and Hungary (2)

[6] 1912–1914 only. [7] 1919 only. [8] 1915–1918 only. [9] 1915 only.

TABLE II.—

1. *Western and Northern*

Years	Belgium	Denmark	Faroe Islands, Iceland	England and Wales	Scotland	Northern Ireland	Irish Free State	Islands in the British Seas	France (1)	France (2)
1841–45	135,412	40,030	2,237	528,301	(86,661)	(247,380)		(3,612)	976,030	996,785
1846–50	124,524	42,935	2,326	569,446	(92,562)	(213,276)		(3,864)	949,594	971,084
1851–55	130,833	47,045	2,635	624,343	(99,598)	(174,440)		4,109	939,799	962,024
1856–60	143,406	51,724	2,816	669,987	104,285	(165,004)		3,906	967,388	990,383
1861–65	152,116	51,655	2,825	724,970	109,764	(148,278)		3,988	1,004,934	
1866–70	158,910	53,772	2,666	775,049	114,395	146,407		3,850	998,760	
1871–75	169,275	56,643	2,557	831,735	120,376	144,924		3,648	928,822	981,118
1876–80	174,245	61,998	2,604	886,021	126,086	135,532		3,512	941,056	993,678
1881–85	175,601	65,899	2,622	892,880	126,409	120,297		3,549	934,577	983,833
1886–90	176,056	67,333	2,440	885,168	123,977	109,796		3,745	882,664	930,120
1891–95	181,389	67,821	2,727	907,853	125,800	105,980		3,522	857,291	905,800
1896–00	191,700	71,000	2,754	923,177	130,209	105,024		3,573	848,710	899,696
1901–05	193,481	73,025	2,717	938,654	132,399	102,263		3,305	830,977	883,535
1906–10	181,617	75,274	2,805	920,988	128,987	102,408		3,191	783,132	833,453
1911–14	167,619	73,590	2,850	878,715	122,273	30,073	70,350	2,909	737,207	781,697
1915–19	103,739	70,657	3,023	724,716	105,277	26,672	63,332	2,158	430,721	449,121
1920	165,143	82,077	3,292	957,782	136,546	32,521	67,015	2,749	833,518	
1921	164,738	78,815	3,215	848,814	123,201	29,710	61,010	2,485	811,776	
1922	155,052	73,899	3,214	780,124	115,085	29,531	58,849	2,548	759,702	
1923	156,881	74,827	3,264	758,131	111,902	30,097	61,690	2,518	761,258	
1924	154,555	73,836	3,156	729,933	106,900	28,496	63,402	2,479	753,519	
1925	154,298	71,897	3,153	710,582	104,137	27,686	62,069	2,421	770,060	
1926	149,943	70,734	3,267	694,563	102,449	28,162	61,176	2,452	767,475	
1927	145,275	68,024	3,221	654,172	96,672	26,676	60,054	2,312	743,833	
1928	146,981	68,516	3,162	660,267	96,822	25,963	59,176	2,316	749,347	
1929	146,206	65,297	3,219	643,673	92,880	25,410	58,280	2,202	730,060	
1930	151,406	66,303	3,441	648,811	94,549	25,879	58,353	2,273	749,953	
1931	148,538	64,266	3,413	632,081	92,220	25,673	57,086	2,260	733,909	
1932	144,835	64,650	3,290	613,972	91,000	25,107	56,240	2,194	722,246	
1933	135,769	62,780	(3,200)	580,413	86,546	24,659	57,364	2,246	682,680	

All data—with the exception of France (2), 1841–1860, 1871–1919, Germany (2), 1841–1933, and Total (2), 1841– the present territory, but those for Germany (2), 1841–1910, are slightly too high as they include the small territorie columns, except France (1) and Germany (1), and adding for 1911–1914 and 1915–1919 : 6,052 and 3,636 respectivel

2. *Other Countries*

Years	Austria (1)	Austria (2)	Bulgaria	Czecho-slovakia	Danzig	Estonia	Finland	Hungary (1)	Hungary (2)	Italy
1871–75	823,171	160,447	—	—	—	—	68,319	659,858	—	998,226
1876–80	841,119	165,180	—	—	—	—	73,360	685,200	—	1,029,45
1881–85	861,795	166,763	—	—	—	—	75,629	714,305	—	1,094,07
1886–90	885,314	169,707	116,172[4]	—	—	—	79,243	741,057	—	1,118,34
1891–95	912,009	176,328	125,396	—	—	—	77,916	743,309	—	1,112,80
1896–00	948,914	184,507	147,813	—	—	—	85,558	738,765	—	1,084,67
1901–05	954,578	187,071	158,141	453,887	—	—	87,787	735,606	—	1,072,52
1906–10	941,917	180,446	176,163	439,301	—	—	92,799	750,000	—	1,106,47
1911–14	888,957[5]	166,129	164,753	407,208	—	—	89,585	745,299	266,822	1,116,02
1915–19	—	105,588	121,689	233,252	—	—	77,479	386,494[7]	159,864	826,10
1920	—	146,644	192,665	364,139	11,273	—	84,714	—	249,458	1,158,04
1921	—	151,138	196,942	399,019	11,103	—	82,165	—	255,453	1,163,21
1922	—	150,958	202,602	388,339	9,967	22,255	80,140	—	249,279	1,175,87
1923	—	146,885	192,381	379,808	9,619	22,347	81,961	—	238,971	1,155,17
1924	—	142,141	207,117	363,331	9,993	21,441	78,057	—	221,462	1,124,47
1925	—	135,841	196,312	355,989	9,696	20,445	78,260	—	235,480	1,109,76
1926	—	127,254	202,730	351,706	9,129	19,977	76,875	—	229,484	1,094,58
1927	—	118,741	183,334	335,709	8,863	19,705	75,611	—	218,548	1,093,77
1928	—	116,783	185,189	337,269	8,911	20,064	77,523	—	224,693	1,072,31
1929	—	112,121	173,417	326,307	8,852	19,110	76,011	—	215,463	1,037,70
1930	—	112,601	179,973	333,253	8,811	19,471	75,236	—	219,784	1,092,67
1931	—	106,661	171,180	318,452	8,304	19,509	71,866	—	206,925	1,026,19
1932	—	102,179	185,578	312,643	8,076	19,742	69,352	—	205,529	990,99
1933	—	96,403	174,095	287,454	7,719	18,208	65,047	—	193,911	995,97

All data—with the exception of Austria (2), 1871–1918, Czechoslovakia, 1901–1918, and Hungary (2), 1911-1918– present territory. The data for Australia and New Zealand do not include the Aborigines.

[1] 1872–1875 only. [2] 1873–1875 only. [3] 1878–1880 only. [4] 1888–1890 only. [5] 1911–1913 only.

YEARLY BIRTHS.

Europe, 1841–1933.

Germany		Holland	Luxemburg	Norway	Sweden	Switzerland	Total	Years
(1)	(2)						(2)	
1,181,971	1,068,547	102,338	(5,814)	39,080	100,843	(70,415)	3,427,455	1841–45
1,195,500	1,081,183	96,984	(5,348)	42,177	104,822	(66,020)	3,416,551	1846–50
1,198,120	1,082,573	105,758	(5,491)	46,898	113,191	(64,123)	3,463,061	1851–55
1,281,820	1,158,212	109,539	(6,002)	51,562	125,647	(70,936)	3,653,409	1856–60
1,377,834	1,245,012	121,359	(6,229)	52,548	132,556	(76,686)	3,832,920	1861–65
1,461,003	1,320,436	126,320	(6,420)	51,450	123,658	(77,703)	3,959,796	1866–70
1,619,251	1,424,461	133,661	(6,545)	53,724	131,033	81,833	4,141,533	1871–75
1,730,437	1,525,537	143,689	(6,624)	59,181	136,427	87,642	4,342,776	1876–80
1,704,741	1,508,877	146,007	(6,520)	59,646	135,206	82,345	4,309,691	1881–85
1,759,288	1,560,534	150,192	(6,233)	60,381	136,434	80,574	4,292,983	1886–90
1,844,068	1,642,502	155,052	6,171	61,573	132,575	84,147	4,382,912	1891–95
1,956,523	1,743,145	161,671	6,683	65,142	135,170	91,817	4,530,761	1896–00
2,010,625	1,795,206	169,896	7,421	65,202	136,198	95,371	4,598,673	1901–05
1,988,104	1,776,746	170,796	7,444	61,978	137,483	94,795	4,497,965	1906–10
1,849,428	1,649,083	171,792	6,992	61,635	131,376	90,151	4,247,157	1911–14
1,110,116	997,168	169,735	4,845	61,267	119,736	73,211	2,978,293	1915–19
1,579,446	1,564,927	195,016	5,621	68,881	138,753	81,190	4,335,031	1920
1,560,447	1,543,652	191,440	5,494	64,610	127,723	80,808	4,137,491	1921
1,404,215	1,424,763	183,754	5,094	62,908	116,946	76,290	3,847,759	1922
1,297,449	1,318,489	187,512	5,468	61,731	113,435	75,551	3,722,754	1923
1,270,820	1,290,764	182,430	5,369	58,021	109,055	73,508	3,635,423	1924
1,292,499	1,311,259	178,545	5,619	54,066	106,292	72,570	3,634,654	1925
1,227,900	1,245,471	177,493	5,639	54,163	102,007	72,118	3,537,112	1926
1,161,719	1,178,892	175,098	5,864	50,175	97,994	69,533	3,377,795	1927
1,182,815	1,199,998	179,028	6,114	49,881	97,868	69,594	3,415,033	1928
1,147,458	1,164,062	177,216	6,210	48,372	92,861	69,006	3,324,954	1929
1,127,450	1,144,151	182,310	6,377	47,844	94,220	69,855	3,345,725	1930
1,031,770	1,047,775	177,387	5,988	45,989	91,074	68,249	3,195,908	1931
978,210	993,126	178,525	5,295	45,451	89,733	68,650	3,104,314	1932
956,915	971,123	171,287	4,894	42,610	84,881	67,509	2,977,961	1933

1919—refer to the territory of the respective period. The data for France (2), Germany (2), and Total (2) refer to ceded to Belgium and Denmark through the Treaty of Versailles. Column Total was arrived at by summing up all for the small territories ceded to Belgium and Denmark.

1871–1933.

Latvia	Lithuania	Poland	Portugal	Rumania	Russia (Europe)	Spain	Yugoslavia	Australia	New Zealand	Years
—	—	—	—	153,923 [2]	3,437,575	—	56,867	65,586	11,978	1871–75
—	—	—	—	161,811	3,568,983	600,228 [3]	58,591	73,108	17,641	1876–80
—	—	—	—	200,104	3,892,133	623,534	85,834	86,343	19,296	1881–85
—	—	—	—	211,988	4,152,899	633,033	90,522	103,073	18,814	1886–90
—	—	—	—	225,375	4,326,996	635,284	97,153	107,882	18,282	1891–95
—	—	—	—	236,283	4,714,294	630,576	96,833	100,595	18,937	1896–00
—	—	—	—	247,913	4,945,508	664,626	101,280	102,644	21,885	1901–05
—	—	—	—	273,255	5,157,904	650,447	110,144	112,131	25,559	1906–10
—	—	—	196,752 [6]	312,733	5,312,580	623,090	—	132,245	27,534	1911–14
—	36,165	807,703 [8]	184,249	319,544 [9]	—	614,333	—	128,858	26,988	1915–19
—	47,642	861,201	202,908	539,359	—	623,339	422,267	136,406	29,921	1920
—	51,864	890,440	197,022	620,460	—	648,892	442,530	136,198	28,567	1921
41,146	58,064	983,139	203,727	613,726	—	656,093	420,910	137,496	29,006	1922
41,796	60,869	1,014,796	207,172	608,763	—	662,576	432,779	135,222	27,967	1923
41,172	63,864	1,000,144	207,440	622,580	—	653,085	442,835	134,927	28,014	1924
41,314	63,743	1,036,660	208,434	605,655	4,922,879	644,741	437,070	135,792	28,153	1925
41,073	63,655	989,183	214,633	607,864	4,954,440	663,401	459,035	133,162	28,473	1926
41,610	66,114	958,733	199,399	603,284	5,032,954	636,028	451,617	133,698	27,881	1927
39,126	65,945	990,993	211,314	623,860	4,999,377	666,240	437,523	134,078	27,200	1928
35,673	63,083	994,101	200,874	600,556	(4,555,000)	653,668	452,544	129,480	26,747	1929
37,835	64,164	1,022,811	202,529	625,341	—	660,860	489,173	128,399	26,797	1930
36,972	63,419	965,795	204,120	604,982	—	649,766	470,094	118,509	26,622	1931
37,366	65,371	932,116	208,062	662,049	—	670,670	465,327	110,933	24,884	1932
34,576	62,145	868,675	204,315	597,621	—	667,818	—	111,269	24,334	1933

refer to the territory of the respective period. All data for Austria (2), Czechoslovakia, and Hungary (2) refer to the

[6] 1912–1914 only. [7] 1915–1918 only. [8] 1919 only. [9] 1915 only.

TABLE III.—WOMEN OF CHILD-BEARING AGE, 1907–1934.

Country	Date	Total Population	Women 15–50 Years	Per Cent
		1. *Western and Northern Europe.*		
Belgium .	31 Dec. 1910	7,423,784	1,919,636	25·86
	31 Dec. 1920	7,406,299	2,056,435	27·77
Denmark.	1 Feb. 1911	2,757,076	689,816	25·02
	1 Feb. 1921	3,267,831	848,626	25·97
	5 Nov. 1930	3,550,656	958,344	26·99
England	2 Apr. 1911	36,070,492	9,988,232	27·69
and Wales	19 June 1921	37,886,699	10,712,239	28·27
	26 Apr. 1931	39,952,377	11,192,060	28·01
	30 June 1933	40,350,000	11,148,300	27·63
Scotland .	2 Apr. 1911	4,760,904	1,271,616	26·71
	19 June 1921	4,882,497	1,336,724	27·38
	26 Apr. 1931	4,842,980	1,306,411	26·98
Ireland .	2 Apr. 1911	4,390,219	1,079,780	24·60
	18 Apr. 1926	4,228,553	1,038,218	24·55
Northern	2 Apr. 1911	1,250,531	328,233	26·25
Ireland	18 Apr. 1926	1,256,561	329,484	26·22
Irish Free	2 Apr. 1911	3,139,688	751,547	23·94
State	18 Apr. 1926	2,971,992	708,734	23·85
France .	5 Mar. 1911	39,192,133	10,138,099	25·87
	6 Mar. 1921	38,797,540	10,703,875	27·59
	7 Mar. 1926	40,228,481	10,961,293	27·25
Germany .	1 Dec. 1910	57,798,427	14,719,865	25·47
	8 Oct. 1919	60,412,084	17,417,543	28·83
	16 June 1925	62,410,619	18,095,155	28·99
	30 June 1929	63,958,000	18,680,000	29·21
	30 June 1931	64,630,000	18,683,000	28·91
Saar Terri-				
tory .	19 July 1927	770,030	219,441	28·50
Holland .	31 Dec. 1909	5,858,175	1,453,752	24·82
	31 Dec. 1920	6,865,314	1,749,988	25·49
	31 Dec. 1930	7,935,565	2,058,727	25·94
Norway .	1 Dec. 1910	2,357,790	580,994	24·64
	1 Dec. 1920	2,649,775	669,240	25·26
	1 Dec. 1930	2,814,194	739,068	26·26
Sweden .	31 Dec. 1910	5,522,403	1,338,700	24·24
	31 Dec. 1915	5,712,740	1,399,300	24·49
	31 Dec. 1920	5,904,489	1,488,863	25·22
	31 Dec. 1925	6,053,562	1,574,600	26·01
	31 Dec. 1930	6,141,571	1,637,950	26·67
Switzerland	1 Jan. 1911	3,755,740	977,311	26·02
	1 Jan. 1921	3,881,873	1,076,200	27·72
	1 Dec. 1930	4,066,400	1,144,748	28·15
		2. *Other Countries*		
Austria .	31 Dec. 1910	6,645,984	1,730,993	26·05
	31 Dec. 1922	6,533,702	1,879,370	28·76
	31 Dec. 1927	6,678,527	1,945,386	29·13
	22 Mar. 1934	6,760,233	1,857,336	27·47
Bulgaria .	31 Dec. 1910	4,337,513	968,764	22·33
	31 Dec. 1920	4,846,971	1,204,393	24·85
	31 Dec. 1926	5,478,741	1,397,254	25·50

TABLE III.—WOMEN OF CHILD-BEARING AGE, 1907–1934—*continued.*

Country	Date	Total Population	Women 15–50 Years	Per Cent
	2. *Other Countries*—continued.			
Czecho-slovakia	15 Feb. 1921	13,613,172	3,744,295	27·50
Danzig	1 Nov. 1923	366,730	103,443	28·21
Estonia	28 Dec. 1922	1,107,059	310,471	28·04
	1 Mar. 1934	1,126,413	309,497	27·48
Finland	31 Dec. 1910	3,115,197	761,217	24·44
	31 Dec. 1920	3,364,807	871,995	25·92
	31 Dec. 1930	3,667,067	984,932	26·86
Greece	27 Oct. 1907	2,631,952	661,325	25·13
	1 Jan. 1921	5,021,790	1,285,550	25·60
	16 May 1928	6,204,684	1,634,983	26·35
Hungary	31 Dec. 1910	7,606,971	1,870,147	24·58
	31 Dec. 1920	7,980,143	2,186,446	27·40
	31 Dec. 1930	8,688,319	2,423,645	27·90
Italy	10 June 1911	34,671,377	8,525,145	24·59
	1 Dec. 1921	38,710,576	9,945,287	25·69
	21 Apr. 1931	41,176,671	10,874,984	26·41
Latvia	14 June 1920	1,596,131	445,523	27·91
	10 Feb. 1925	1,844,805	532,639	28·87
	10 Feb. 1930	1,900,045	545,182	28·69
Lithuania proper	17 Sept. 1923	2,028,971	556,007	27·40
Memel Territory	20 Jan. 1925	141,645	38,281	27·03
Poland	30 Sept. 1921	25,694,700	6,798,699	26·46
Portugal	1 Dec. 1911	5,960,056	1,533,354	25·73
	1 Dec. 1920	6,032,991	1,607,009	26·64
	1 Dec. 1930	6,825,883	1,803,076	26·42
Rumania	19 Dec. 1912	7,234,920	1,719,991	23·77
Russia (Europe)	17 Dec. 1926	82,045,588	21,886,051	26·68
Spain	31 Dec. 1910	19,995,686	4,999,041	25·00
	31 Dec. 1920	21,389,842	5,524,960	25·83
Canada	1 June 1911	7,206,643	1,726,576	23·96
	1 June 1921	8,787,949	2,140,979	24·36
	1 June 1931	10,376,786	2,570,790	24·77
United States of America	15 Apr. 1910	91,972,266	23,887,916	25·97
	1 June 1920	105,710,620	27,431,979	25·95
	1 Apr. 1930	122,775,046	32,635,510	26·58
Australia	3 Apr. 1911	4,455,005	1,168,351	26·23
	4 Apr. 1921	5,435,734	1,407,879	25·90
	31 Dec. 1932	6,604,517	1,727,406	26·15
New Zealand	2 Apr. 1911	1,008,468	261,798	25·96
	15 Oct. 1916	1,099,449	295,455	26·87
	17 Apr. 1921	1,218,913	321,323	26·36
	20 Apr. 1926	1,344,469	355,931	26·47
	1 Apr. 1934	1,476,026	386,536	26·19

All data refer to the present territory, except those for Belgium; Denmark, 1911; France, 1911; Bulgaria, 1910; Greece, 1907; Italy, 1911; and Rumania, 1912 (which refer to the territory of the respective period). The data for Germany exclude the Saar Territory.

TABLE IV.—WOMEN OF CHILD-BEARING AGE BY QUINQUENNIAL AGE GROUPS, 1871–1933.

Period	15–19 Years	20–24 Years	25–29 Years	30–34 Years	35–39 Years	40–44 Years	45–49 Years	Total
1. WESTERN AND NORTHERN EUROPE								
Denmark								
1878–1884	88,600	87,800	76,800	66,700	61,300	55,800	49,600	486,600
1885–1894	96,700	90,600	81,600	77,900	67,800	58,600	54,400	527,600
1895–1900	110,465	99,996	89,230	81,569	73,500	69,291	59,277	583,328
1901–1905	121,100	109,500	95,800	86,000	77,100	75,200	63,700	628,400
1906–1910	125,500	115,700	105,600	95,500	83,100	76,100	67,000	668,500
1911–1915	134,900	120,700	113,400	103,000	92,300	79,500	71,500	715,300
1916–1920	144,800	133,200	119,300	111,900	100,600	89,500	77,300	776,600
1921–1925	160,922	150,947	135,912	125,063	113,305	102,716	89,030	877,895
1926–1930	167,000	158,400	148,200	135,500	120,200	111,000	99,000	939,300
France								
1892–1897	1,675,400	1,708,100	1,439,800	1,369,400	1,292,600	1,200,300	1,151,700	9,837,300
1898–1903	1,644,334	1,620,919	1,514,939	1,409,698	1,349,842	1,242,456	1,131,095	9,913,283
1904–1907	1,602,406	1,598,493	1,556,951	1,434,856	1,369,646	1,271,365	1,191,245	10,024,962
1908–1913	1,594,129	1,567,883	1,551,510	1,497,442	1,403,587	1,299,976	1,223,572	10,138,099
1914–1919 [1]	1,350,000	1,345,000	1,340,000	1,295,000	1,220,000	1,125,000	1,025,000	8,700,000
1920–1923	1,719,248	1,641,524	1,554,521	1,514,556	1,498,813	1,442,321	1,332,892	10,703,875
1925–1927	1,701,352	1,706,799	1,655,206	1,549,804	1,503,127	1,451,055	1,393,950	10,961,293
1928–1931	1,620,000	1,710,000	1,730,000	1,600,000	1,525,000	1,460,000	1,415,000	11,060,000
Germany								
Nine States [2]								
1881–1890	119,369	106,195	93,172	85,282	76,138	72,074	63,456	615,686
1891–1900	132,484	122,374	107,653	95,514	83,565	76,813	68,284	686,687
1901–1910	148,352	134,766	120,280	112,125	99,201	88,068	76,331	779,123

Saxony								
1911–1914	252,300	236,200	203,400	191,900	172,600	141,000	127,000	1,324,500
1915–1919	250,000	236,000	218,000	203,000	175,000	170,000	143,000	1,395,000
1920–1923	255,000	246,000	229,000	210,000	188,000	174,000	154,000	1,456,000
1924–1926	257,560	257,137	240,067	217,809	203,397	174,910	167,963	1,518,843
1927–1930	244,000	261,000	249,000	229,000	211,000	185,000	165,000	1,544,000
1931	218,000	263,000	255,000	238,000	221,000	193,000	171,000	1,559,000
Prussia								
1930–1932	1,711,991	1,955,829	1,869,113	1,724,674	1,567,686	1,411,442	1,236,926	11,477,661
Whole Country								
1924–1926	3,257,899	3,085,907	2,839,342	2,552,713	2,318,713	2,054,090	1,986,491	18,095,155
1929	3,120,000	3,178,000	2,993,000	2,741,000	2,448,000	2,227,000	1,973,000	18,680,000
1931	2,777,000	3,181,000	3,042,000	2,812,000	2,546,000	2,290,000	2,035,000	18,683,000
Norway								
1871–1876	88,359	78,478	67,429	56,932	53,001	50,525	47,698	442,422
1881–1885	93,580	83,999	76,025	66,541	57,029	49,442	46,254	472,870
1889–1892	93,460	82,419	76,489	68,340	62,703	54,098	48,551	486,060
1899–1905	110,100	98,200	84,200	73,000	69,000	62,100	57,600	554,200
1910–1911	118,354	100,232	87,173	80,696	70,505	63,418	60,616	580,994
1916–1920	129,200	119,100	102,200	87,900	77,700	72,900	63,500	652,500
Sweden								
1871–1875	200,139	173,343	156,069	146,677	140,771	130,439	127,369	1,074,807
1876–1880	222,504	190,398	164,100	148,737	140,030	134,100	124,108	1,123,977
1881–1885	218,533	201,767	171,664	152,432	140,634	132,445	126,792	1,144,267
1886–1890	207,300	195,648	182,525	159,523	143,767	133,204	125,552	1,147,519
1891–1895	219,376	180,733	173,507	169,453	151,358	136,737	126,634	1,157,798

[1] 77 provinces only (excluding 10 occupied provinces).
[2] Hesse, Oldenburg, Brunswick, Saxony-Weimar, Saxony-Altenburg, and the Schwarzburg and Reuss principalities.

TABLE IV.—WOMEN OF CHILD-BEARING AGE BY QUINQUENNIAL AGE GROUPS, 1871–1933—*continued*.

Period	15–19 Years	20–24 Years	25–29 Years	30–34 Years	35–39 Years	40–44 Years	45–49 Years	Total
				Sweden—continued.				
1896–1900	231,833	201,023	168,936	165,543	162,562	145,136	130,916	1,205,949
1901–1905	244,310	211,221	187,663	161,841	159,859	156,549	139,259	1,260,702
1906–1910	248,029	224,156	198,117	179,308	155,622	153,730	150,240	1,309,202
1911–1915	256,645	232,400	214,077	191,957	173,783	150,502	148,267	1,367,631
1916–1920	269,649	244,691	222,970	206,490	185,671	167,961	144,978	1,442,410
1921–1925	279,037	258,832	236,101	216,743	200,840	179,802	162,110	1,533,465
1926–1930	281,335	269,323	249,417	228,714	210,721	195,210	174,100	1,608,820
1931	272,100	275,698	256,939	237,343	217,985	202,614	182,125	1,644,804
				2. EASTERN AND SOUTHERN EUROPE.				
				Austria				
1895–1900	1,239,837	1,120,595	982,907	1,686,230		1,380,245		6,409,814
1901–1905	1,307,156	1,165,520	1,021,728	1,762,938		1,432,336		6,689,678
1906–1910	1,372,737	1,191,869	1,059,292	1,846,035		1,497,408		6,967,341
1913	1,445,044	1,221,912	1,093,164	1,929,130		1,562,480		7,251,730
1928	311,744	313,025	307,431	285,483	257,809	246,378	226,208	1,948,078
1931–1932	256,750	307,064	308,305	294,549	271,623	248,271	232,738	1,919,300
				Bulgaria				
1901–1905	204,559	153,709	128,102	111,911	97,469	85,788	73,074	854,612
1906–1910	209,319	180,509	152,993	118,173	103,788	89,046	76,268	930,096
1921–1926	282,830	243,469	201,448	168,968	160,965	135,924	107,220	1,300,824
1926–1927	297,144	265,367	224,787	175,068	162,084	154,606	118,198	1,397,254
				Czechoslovakia				
1920–1921	746,605	681,644	568,790	494,570	453,659	414,341	384,686	3,744,295

				Estonia				
1922–1923	54,715	52,517	46,386	43,550	40,539	36,995	35,769	310,471
				Finland				
1871–1875	87,829	83,356	76,928	69,301	59,908	55,360	50,593	483,275
1876–1880	93,535	85,601	81,102	74,245	67,340	56,215	50,358	508,396
1881–1885	89,672	91,252	82,784	78,414	71,551	64,241	53,070	530,984
1886–1890	104,305	87,462	88,021	79,458	74,970	68,171	61,002	563,389
1891–1900	121,500	102,300	98,400	80,800	79,800	71,100	66,500	620,400
1901–1910	137,440	127,776	114,903	101,438	85,292	76,944	72,311	716,104
1911–1920	152,931	137,489	129,057	119,501	106,759	93,529	78,435	817,701
1921–1930	175,155	161,258	143,070	128,245	119,807	110,462	97,942	935,939
				Hungary				
1900–1901	989,171	792,825	671,561	654,348	593,081	574,534	458,666	4,734,186
1902–1907	1,012,994	824,168	722,894	669,589	593,728	574,755	480,102	4,878,230
1908–1913	1,048,727	871,183	799,893	692,451	594,699	575,085	512,257	5,094,295
1920–1921	426,006	405,609	340,756	297,775	275,589	240,291	200,420	2,186,446
1930–1931	420,864	423,268	376,726	364,341	310,772	274,704	252,970	2,423,645
				Italy				
1931	2,419,952[1]	1,508,992[2]	1,650,402	1,520,352	1,370,685	1,273,065	1,131,536	10,874,984
				Latvia				
1929	86,063	90,768	88,614	80,226	69,997	66,008	62,043	543,719
				Lithuania				
1928	147,795	131,370	100,371	74,537	62,404	60,529	51,161	628,167
				Portugal				
1930–1931	345,135	322,778	288,419	239,540	220,491	205,348	181,365	1,803,076

[1] 15 to 20 years.

[2] 21 to 24 years.

TABLE IV.—WOMEN OF CHILD-BEARING AGE BY QUINQUENNIAL AGE GROUPS, 1871–1933—*continued*.

Period	15–19 Years	20–24 Years	25–29 Years	30–34 Years	35–39 Years	40–44 Years	45–49 Years	Total
				Serbia				
1900–1901	155,242[1]	75,917[2]	103,728	59,558	84,293	41,652	59,972	580,362
				Ukraine				
1926–1927	1,773,820	1,520,273	1,270,488	1,026,957	833,989	688,103	575,040	7,688,670
				3. OTHER COUNTRIES.				
				Canada (excluding Yukon and North West Territories)				
1921–1925[3]	282,624	262,290	256,274	237,910	226,757	187,353	153,089	1,606,297
1926–1927[3]	308,739	273,997	256,316	240,349	236,102	200,141	166,634	1,682,278
1926–1927	443,357	388,697	353,987	324,545	311,513	264,288	220,559	2,306,946
1931	513,862	447,093	375,959	340,319	329,080	298,080	263,465	2,567,858
				Australia [4]				
1908–1913	223,138	219,495	189,669	160,878	140,467	125,462	109,242	1,168,351
1920–1922	229,280	233,283	237,000	221,492	189,944	161,222	135,658	1,407,879
1932–1933	306,942	273,030	243,914	243,368	244,921	224,856	190,375	1,727,406
				New Zealand [4]				
1911–1915	44,590	46,045	47,642	44,693	38,553	30,310	24,020	275,853
1916–1920	48,935	47,363	48,093	47,107	45,203	37,544	29,712	303,957
1921–1922	54,076	49,697	49,707	48,638	47,688	43,559	33,463	326,828
1923–1929	60,948	55,307	52,086	50,474	48,936	47,636	41,147	356,534
1930–1931	65,704	61,277	55,455	51,978	49,362	49,107	45,657	378,540
1932	66,106	62,541	57,290	52,118	50,151	48,293	47,059	383,558
1933	65,324	63,200	58,428	52,454	50,368	47,967	47,370	385,111

[1] 15 to 20 years. [2] 21 to 24 years. [3] Excluding also Province of Quebec. [4] Excluding Aborigines.

TABLE V.—YEARLY BIRTHS BY QUINQUENNIAL AGE GROUPS OF MOTHERS, 1871–1933.

Period	Under 20 Years	20–24 Years	25–29 Years	30–34 Years	35–39 Years	40–44 Years	45 and more Years	Total	Female Live-born
1. WESTERN AND NORTHERN EUROPE.									
Denmark [1]									
1878–1884	1,246	11,637	18,408	16,307	11,663	5,299	530	65,090	31,182
1885–1894	1,499	12,018	19,071	17,510	12,433	5,276	499	68,306	32,877
1895–1900	1,911	14,033	19,997	17,043	12,494	5,468	486	71,432	34,404
1901–1905	2,437	15,670	21,581	17,041	11,565	5,028	467	73,789	35,568
1906–1910	3,074	17,165	21,987	17,438	11,261	4,631	394	75,950	36,716
1911–1915	3,225	16,608	21,302	16,623	11,038	4,308	394	73,498	35,590
1916–1920	3,194	17,136	20,698	16,570	10,718	4,276	358	72,950	35,205
1921–1925	3,856	18,295	21,867	16,182	10,543	4,180	368	75,291	36,318
1926–1930	3,819	17,064	19,863	14,919	8,830	3,467	311	68,273	32,999
France									
1892–1897 [2]	47,825	225,208	258,280	194,233	119,347	46,971	7,736	899,600	419,940
1898–1903 [2]	45,806	228,826	257,355	181,259	117,146	44,344	6,459	881,195	412,199
1904–1907 [2]	45,394	220,773	246,323	174,688	104,093	41,552	6,113	838,936	392,496
1908–1913 [2]	45,324	218,461	232,822	163,339	99,388	35,359	3,315	798,008	372,762
1914–1919 [2] [3]	20,242	99,122	118,541	94,333	65,055	26,205	2,393	425,891	198,310
1920–1923	41,267	215,751	238,381	162,291	96,032	34,785	3,056	791,563	385,504
1924	43,013	215,721	221,199	153,429	86,151	31,244	2,762	753,519	368,256
1925–1927	46,241	221,703	222,322	152,916	84,753	29,881	2,642	760,458	371,739
1928–1931	47,022	217,840	219,177	145,441	81,470	27,363	2,504	740,817	362,432

[1] Confinements.
[2] Live- and still-born.
[3] 77 provinces only (excluding 10 occupied provinces).

TABLE V.—YEARLY BIRTHS BY QUINQUENNIAL AGE GROUPS OF MOTHERS, 1871–1933—*continued.*

Period	Under 20 Years	20–24 Years	25–29 Years	30–34 Years	35–39 Years	40–44 Years	45 and more Years	Total	Female Live-born
1. WESTERN AND NORTHERN EUROPE—*continued.*									
Germany									
Nine States [2] [3]									
1881–1890	2,243	18,820	25,860	20,324	13,869	5,781	649	87,546	—
1891–1900	2,737	22,361	29,673	22,101	13,912	5,351	560	96,695	—
1901–1910	3,454	23,725	31,366	22,252	13,698	5,193	489	100,177	—
Saxony									
1911–1914 [2]	7,249	37,769	37,071	24,002	15,514	5,341	394	127,340	59,807
1915–1919 [2]	2,521	16,958	21,468	14,912	9,323	3,669	281	69,132	32,290
1920–1923 [2]	4,672	30,639	34,239	22,670	11,840	4,084	295	108,439	50,631
1924–1926	4,900	25,283	26,497	16,813	8,989	2,794	204	85,480	41,577
1927–1930	5,557	24,499	24,198	14,884	7,515	2,380	152	79,185	38,414
1931 [2]	4,949	21,415	20,741	12,639	6,376	2,029	121	68,270	32,044
Prussia [2]									
1930–1932	33,891	174,231	206,383	140,144	77,832	27,955	2,823	663,259	311,218
Norway									
1871–1876	581	7,744	13,834	13,284	10,844	6,552	1,547	54,386	26,533
1881–1885	686	8,495	15,773	15,344	11,648	6,334	1,366	59,646	28,915
1889–1892	681	8,054	15,255	15,314	12,754	6,680	1,374	60,112	29,135
1899–1905	1,228	10,788	17,152	15,387	12,563	6,840	1,248	65,206	31,683
1910–1911	1,244	10,411	16,082	15,160	11,614	5,865	1,089	61,465	29,898
1916–1920	1,423	12,275	17,127	15,011	10,992	5,791	895	63,514	30,697

Sweden [1]

1871–1875	1,819	18,358	32,329	34,167	28,594	15,822	2,304	133,393	63,819
1876–1880	2,222	20,357	34,446	34,739	28,664	15,765	2,364	138,557	66,488
1881–1885	2,245	21,220	34,572	34,321	27,460	15,071	2,141	137,030	65,700
1886–1890	2,230	21,013	36,230	34,883	27,379	14,392	2,076	138,203	66,600
1891–1895	2,553	19,492	33,560	35,380	27,260	14,035	1,828	134,108	64,445
1896–1900	3,395	23,253	32,884	33,447	28,031	14,070	1,657	136,737	65,701
1901–1905	3,893	25,234	36,280	31,333	25,525	13,749	1,600	137,614	66,270
1906–1910	4,696	27,322	36,905	33,036	23,237	12,133	1,506	138,835	66,623
1911–1915	5,000	26,337	34,953	30,387	22,657	10,421	1,203	130,958	63,042
1916–1920	4,569	25,803	33,149	28,912	20,610	9,866	1,061	123,970	59,628
1921–1925	5,000	25,163	31,208	26,077	18,776	8,660	983	115,867	55,714
1926–1930	5,021	22,355	26,516	21,715	14,930	6,841	743	98,121	47,226
1931	4,958	21,998	25,367	20,400	13,267	5,769	653	92,412	44,292

2. Eastern and Southern Europe.

Austria

1895–1900	35,271	202,209	260,619	375,031		73,795		947,625	460,413
1901–1905	35,797	205,578	265,750	370,969		76,484		954,578	464,317
1906–1910	38,990	206,423	259,433	362,971		74,100		941,917	458,055
1913	36,810	191,405	239,051	330,919		66,578		864,763	420,080
1928	7,815	29,480	32,370	25,152	15,362	6,707		116,886	56,667
1929	7,321	28,741	31,166	24,056	14,667	6,170		112,121	54,412
1931	7,145	27,471	29,679	23,011	13,880	5,475		106,661	51,615

Bulgaria

1898	4,398	36,049	38,301	28,689	19,508	9,994	4,107	141,046	67,943
1899–1900 [2]	4,368	40,222	40,334	34,073	19,747	10,691	3,965	153,400	73,835
1901–1905	4,808	44,354	39,998	34,628	19,913	10,383	4,058	158,142	76,424

[1] Confinements. [2] Live- and still-born.
[3] Hesse, Oldenburg, Brunswick, Saxony-Weimar, Saxony-Altenburg, and the Schwarzburg and Reuss principalities.

TABLE V.—YEARLY BIRTHS BY QUINQUENNIAL AGE GROUPS OF MOTHERS, 1871–1933—*continued.*

Period	Under 20 Years	20–24 Years	25–29 Years	30–34 Years	35–39 Years	40–44 Years	45 and more Years	Total	Female Live-born
				2. EASTERN AND SOUTHERN EUROPE—*continued.*					
				Bulgaria—continued.					
1906–1910	4,918	52,647	47,011	34,282	21,980	11,050	4,275	176,163	85,215
1911–1912	5,361	49,457	55,513	34,021	21,900	10,109	3,846	180,207	87,025
1918–1920	4,363	35,428	40,700	33,611	23,166	9,032	3,537	149,837	72,247
1921–1926	9,927	59,991	54,938	35,257	25,008	10,718	3,842	199,681	96,732
1926–1927	10,761	59,869	54,543	33,045	21,296	9,899	3,619	193,032	93,124
1928–1931	11,083	57,620	50,914	30,859	17,104	7,428	2,432	177,440	85,931
				Czechoslovakia					
1919	8,907	71,225	90,807	68,475	45,555	17,594	2,525	305,088	146,463
1920–1921	16,290	104,443	113,925	76,725	48,893	18,673	2,630	381,579	183,980
1922–1924	16,708	106,875	115,058	74,173	45,076	17,006	2,263	377,159	182,396
1925–1928	18,769	98,392	105,298	69,231	37,732	14,097	1,649	345,168	167,461
1929–1930 [2]	19,378	99,485	101,446	66,914	35,922	12,528	1,474	337,147	159,946
				Estonia					
1922–1923	517	4,716	6,418	5,274	3,602	1,549	225	22,301	10,836
1924–1929	519	4,345	6,026	4,717	3,097	1,259	161	20,124	9,775
1930–1933	557	4,317	5,582	4,637	2,836	1,178	125	19,232	9,345
				Finland [1]					
1871–1875	1,645	12,499	18,388	17,528	12,137	6,166	999	69,362	33,321
1876–1880	1,891	13,148	19,349	18,116	14,105	6,718	973	74,300	35,800
1881–1885	1,790	13,842	19,151	18,712	14,347	7,795	1,027	76,664	36,862

1886–1890	1,904	13,619	20,847	19,109	15,328	8,259	1,263	80,329	38,654
1891–1900	2,101	15,835	20,800	19,217	15,381	8,220	1,224	82,778	39,786
1901–1910	2,230	17,702	24,351	21,915	15,765	8,155	1,154	91,272	43,926
1911–1920	2,229	16,045	21,639	19,789	15,194	8,045	1,028	83,969	40,245
1921–1930	2,486	17,391	21,394	17,171	12,915	6,819	942	79,118	37,949
1931–1932	2,391	16,624	19,918	16,044	10,530	5,254	778	71,539	34,301
Greece [2]									
1931	7,916	41,157	63,270	45,115	31,369	10,202	2,500	201,529	95,345
Hungary									
1900–1901	56,191	205,319	188,004	246,534		46,172		742,220	361,169
1902–1907	57,409	212,567	190,362	231,757		44,760		736,855	357,571
1908–1913	62,324	218,026	201,697	228,292		41,239		751,578	365,714
1914	65,942	218,184	197,654	227,484		37,647		746,911	363,115
1915	38,459	135,720	127,719	174,607		35,756		512,261	248,812
1916–1918	14,428	74,583	77,576	107,180		23,691		297,458	143,631
1919	11,134	62,317	62,453	77,027		12,184		225,115	108,320
1920–1921	18,565	84,079	70,051	72,560		11,847		257,102	123,994
1922–1925	16,497	74,980	68,497	66,285		10,039		236,298	114,327
1926–1929	17,157	67,579	63,131	64,919		9,261		222,047	107,629
1930–1931 [2]	17,608	68,621	58,670	65,837		8,792		219,528	—
1932 [2]	16,558	66,805	56,233	63,710		8,227		211,533	—
Italy									
1931	71,459 [3]	209,300 [4]	284,320	231,924	155,949	66,144	7,101	1,026,197	500,812

[1] Confinements.
[2] Live- and still-born.
[3] 15 to 20 years.
[4] 21 to 24 years.

TABLE V.—YEARLY BIRTHS BY QUINQUENNIAL AGE GROUPS OF MOTHERS, 1871–1933—*continued.*

Period	Under 20 Years	20–24 Years	25–29 Years	30–34 Years	35–39 Years	40–44 Years	45 and more Years	Total	Female Live-born
2. EASTERN AND SOUTHERN EUROPE—*continued.*									
Latvia									
1929 [1]	837	7,522	11,161	8,882	5,425	1,965	365	36,157	17,346
1930–1931 [1]	990	7,984	11,352	9,467	5,723	2,127	364	38,007	18,083
1932–1933	930	7,489	10,540	8,983	5,610	2,089	330	35,971	17,442
Lithuania									
1928	1,489	13,858	21,216	16,100	8,929	3,574	779	65,945	32,098
1929–1932	1,518	12,913	20,003	16,303	9,219	3,377	676	64,009	31,017
1933	1,418	12,296	18,829	16,060	9,575	3,368	599	62,145	30,146
Poland									
1927–1928	34,858	241,201	300,640	207,537	128,945	52,241	9,441	974,863	—
Portugal									
1930–1931	8,079	48,877	57,489	41,752	31,522	13,482	2,124	203,325	98,786
Serbia									
1900–1901	12,625 [2]	21,031 [3]	37,840	14,457	11,561	2,421	625	100,560	48,836
1902–1910	12,871 [2]	26,273 [3]	39,090	14,117	11,629	2,278	495	106,753	51,940
Spain									
1922–1929	13,134	128,057	204,549	157,454	102,606	41,700	6,979	654,479	314,182
1930	12,698	133,917	208,092	157,527	101,732	40,375	6,519	660,860	318,458

Ukraine

1925	63,646	361,611	356,906	198,565	145,317	55,580	15,174	1,196,799	578,501
1926–1927	73,105	359,694	329,026	230,479	132,075	57,405	14,353	1,196,137	578,951
1928	70,723	357,265	327,368	191,942	133,151	47,507	11,312	1,139,268	552,509
1929	70,927	341,869	302,896	179,873	127,088	46,162	12,154	1,080,969	—

3. Other Countries

Canada (excluding Yukon and North West Territories)

1921–1925 [4]	10,061	39,136	44,056	34,421	23,438	8,519	874	160,505	78,045
1926–1927 [4]	10,114	37,236	40,038	32,209	22,032	8,344	882	150,855	73,240
1926–1927	13,641	55,758	63,044	50,310	35,394	13,858	1,465	233,470	113,210
1928–1930	14,843	60,031	64,374	49,674	34,548	13,672	1,414	238,556	116,140
1931	15,393	61,371	65,866	49,443	33,901	13,092	1,407	240,473	116,851

Australia [5]

1908–1913	6,060	29,160	35,261	26,554	17,552	6,942	706	122,235	59,608
1914–1919	5,811	29,801	38,793	29,968	18,673	6,687	646	130,379	63,474
1920–1922	6,091	31,208	40,545	31,763	19,549	6,952	592	136,700	66,408
1923–1931	7,942	31,204	36,798	29,145	18,983	6,813	589	131,474	63,953
1932–1933	7,850	28,313	30,899	23,081	14,699	5,718	541	111,101	54,034

New Zealand [5]

1911–1915	933	5,542	8,464	7,009	4,159	1,361	129	27,597	13,415
1916–1920	771	5,192	7,872	7,014	4,767	1,634	152	27,402	13,374
1921–1922	927	6,090	8,441	6,931	4,564	1,681	153	28,787	14,050
1923–1929	1,138	6,150	8,203	6,456	4,134	1,558	137	27,776	13,489
1930–1931	1,238	6,521	8,018	5,913	3,553	1,338	129	26,710	12,970
1932	1,212	6,100	7,583	5,393	3,284	1,197	115	24,884	12,060
1933	1,100	5,984	7,631	5,258	3,112	1,121	128	24,334	11,915

[1] Live- and still-born. [2] 15 to 20 years. [3] 21 to 24 years.
[4] Excluding also Province of Quebec. [5] Excluding Aborigines.

TABLE VI.—YEARL

1. *Western and Norther*

Years	Belgium	Denmark	Faroe Islands, Iceland	England and Wales	Scotland	Northern Ireland	Irish Free State	Islands in the British Seas	France (1)	France (2)
1841–45	97,985	26,055	1,843	349,222	(54,733)	(111,900)		(2,709)	785,973	803,763
1846–50	110,114	29,532	1,885	404,657	(62,931)	(214,374)		(2,898)	848,349	866,769
1851–55	101,397	29,903	1,636	417,447	(63,755)	(122,167)		3,064	867,240	886,290
1856–60	102,657	32,722	2,287	424,696	62,772	(90,968)		2,707	866,205	885,915
1861–65	110,551	33,769	2,351	466,391	69,265	(99,204)		2,883	861,742	
1866–70	118,443	34,390	2,372	492,508	71,974	90,554		3,068	934,003	
1871–75	122,165	35,845	2,008	514,550	77,988	94,651		3,049	907,087	949,687
1876–80	118,632	37,546	1,723	521,112	74,802	98,698		2,932	834,665	874,293
1881–85	117,869	37,442	2,203	517,033	74,396	90,526		2,869	840,839	879,493
1886–90	121,514	39,994	1,669	531,921	74,320	86,105		2,805	842,465	879,451
1891–95	126,274	41,482	1,497	557,078	78,351	85,357		2,901	857,581	894,031
1896–00	120,160	38,775	1,622	557,997	78,021	81,850		2,791	800,500	835,122
1901–05	118,386	37,328	1,519	534,313	77,313	77,747		2,533	766,258	801,022
1906–10	117,318	36,520	1,542	515,442	75,534	75,704		2,398	754,802	787,408
1911–14	113,792	36,252	1,378	509,117	72,675	21,801	50,874	2,365	815,005	847,760
1915–19	119,523	38,858	1,541	537,091	75,055	22,413	53,102	2,385	911,997	947,308
1920	103,312	41,993	1,587	466,130	68,179	21,017	45,521	2,106	671,057	
1921	103,715	36,215	1,708	458,629	66,210	19,301	44,537	2,147	693,125	
1922	107,410	39,452	1,491	486,780	72,905	19,795	44,547	2,228	687,651	
1923	100,852	37,903	1,542	444,785	63,283	18,790	42,217	2,065	665,696	
1924	100,483	38,091	1,730	473,235	70,357	20,299	45,180	2,113	678,942	
1925	102,189	37,083	1,457	472,841	65,507	19,784	43,650	2,104	707,816	
1926	104,742	38,093	1,320	453,804	63,780	18,827	41,740	2,043	712,751	
1927	106,751	40,190	1,439	484,609	65,830	18,216	43,677	2,086	675,540	
1928	105,915	38,484	1,318	460,389	65,271	18,004	41,792	1,977	674,046	
1929	120,782	39,486	1,490	532,492	70,917	19,822	42,991	2,250	738,652	
1930	107,468	38,174	1,522	455,427	64,285	17,148	41,702	1,963	648,886	
1931	108,017	40,578	1,516	491,630	64,229	18,049	42,947	1,967	679,114	
1932	108,226	39,701	1,401	484,129	66,045	17,812	42,984	2,125	660,882	
1933	108,377	38,294	(1,500)	496,465	64,848	18,169	40,539	2,151	661,082	

All data—with the exception of France (2), 1841–1860, 1871–1919, Germany (2), 1841–1933, and Total (2), 1841 the present territory, but those for Germany (2), 1841–1910, are slightly too high as they include the small territori

The number of non-civilians who died in the World War and are not included in the above figures has bee Ireland at 10,000, and for Germany at 150,000. We estimate the total number of deaths of non-civilians thus omitte

Column Total was arrived at by summing up all columns, except France (1), and Germany (1), and adding f and 70,000 and 930,000 respectively for the omitted deaths of non-civilians.

2. *Other Countrie*

Years	Austria (1)	Austria (2)	Bulgaria	Czecho-slovakia	Danzig	Estonia	Finland	Hungary (1)	Hungary (2)	Italy
1871–75	682,786	144,208	—	—	—	—	40,011	699,902	—	827,971
1876–80	662,789	139,959	—	—	—	—	45,135	565,377	—	820,892
1881–85	681,281	142,868	—	—	—	—	47,264	530,300	—	786,656
1886–90	677,631	142,187	—	—	—	—	45,993	543,913	—	811,601
1891–95	679,561	141,688	92,888	—	—	—	50,230	568,186	—	787,001
1896–00	651,019	136,523	86,185	—	—	—	49,800	522,659	—	731,661
1901–05	650,548	135,226	87,536	315,472	—	—	52,043	518,509	—	721,494
1906–10	624,983	131,784	99,601	291,809	—	—	52,155	511,403	—	717,636
1911–14	603,550[4]	126,081	98,653	280,529	—	—	51,465	505,809	176,743	671,480
1915–19	—	147,432	105,803	277,448	—	—	64,736	552,607[6]	175,504	911,609
1920	—	122,775	103,511	257,621	5,986	—	53,304	—	169,717	681,749
1921	—	110,451	106,224	241,607	5,520	—	47,361	—	170,059	670,257
1922	—	113,467	106,063	240,422	6,117	18,401	49,180	—	173,351	689,937
1923	—	99,924	108,250	209,488	5,565	16,630	47,556	—	159,287	654,844
1924	—	98,055	107,818	215,837	5,373	16,918	53,442	—	167,668	662,870
1925	—	94,988	102,212	215,590	4,912	16,680	47,493	—	142,150	670,296
1926	—	99,034	93,409	222,684	5,022	18,047	47,526	—	139,905	680,307
1927	—	99,330	112,119	230,625	5,008	19,356	51,727	—	150,675	639,843
1928	—	96,097	98,713	219,217	4,833	17,785	48,713	—	146,496	645,654
1929	—	97,408	102,653	225,527	5,135	20,178	54,489	—	152,847	667,223
1930	—	90,512	92,771	207,709	4,907	16,610	48,240	—	134,341	576,751
1931	—	93,846	98,469	212,301	4,798	18,077	48,968	—	144,968	609,405
1932	—	93,614	96,180	210,403	4,627	16,641	46,700	—	157,106	610,646
1933	—	88,918	92,561	205,077	4,671	16,472	47,960	—	129,913	574,113

All data—with the exception of Austria (2), 1871–1918, Czechoslovakia, 1901–1918, and Hungary (2), 1911–1918 present territory. The data for Australia and New Zealand do not include the Aborigines.

[1] 1872–1875 only. [2] 1873–1875 only. [3] 1878–1880 only. [4] 1911–1913 only.

DEATHS.

Europe, 1841–1933.

Germany		Holland	Luxemburg	Norway	Sweden	Switzerland	Total	Years
(1)	(2)						(2)	
839,103	758,533	70,988	(4,212)	22,433	65,131	(51,932)	2,421,439	1841–45
921,377	833,170	86,900	(4,731)	25,698	70,991	(50,819)	2,765,469	1846–50
934,961	837,453	77,518	(4 256)	24,954	77,045	(55,292)	2,702,177	1851–55
909,317	814,894	88,261	(4,285)	26,061	80,966	(53,293)	2,672,484	1856–60
968,853	879,250	85,372	(4,517)	30,566	78,912	(56,151)	2,780,924	1861–65
1,074,236	974,892	90,437	(4,780)	30,039	85,554	(61,091)	2,994,105	1866–70
1,175,337	1,034,009	94,552	(4,727)	31,053	78,114	64,479	3,106,877	1871–75
1,152,283	1,015,863	90,504	(4,513)	31,098	82,166	64,671	3,018,553	1876–80
1,185,297	1,049,449	90,010	(4,368)	33,021	80,710	61,082	3,040,471	1881–85
1,176,116	1,042,688	91,591	(4,304)	33,814	77,610	59,750	3,047,536	1886–90
1,183,968	1,055,169	92,145	4,367	34,542	80,267	60,210	3,113,671	1891–95
1,156,092	1,031,295	86,664	4,626	34,096	81,118	58,521	3,012,658	1896–00
1,165,077	1,040,602	86,451	4,650	33,257	80,740	60,001	2,955,862	1901–05
1,100,977	983,596	82,762	4,666	32,539	77,367	58,413	2,851,209	1906–10
1,114,198	993,438	78,760	4,569	32,532	77,685	55,694	2,919,518	1911–14
1,350,510	1,206,631	91,896	4,668	36,615	85,525	57,084	3,469,905	1915–19
923,211	914,094	83,554	3,404	33,634	78,128	55,992	2,589,708	1920
860,199	849,787	78,896	3,444	30,698	73,536	49,518	2,511,466	1921
880,626	890,507	82,249	3,538	32,484	76,343	50,292	2,597,672	1922
857,898	866,754	72,809	3,581	31,543	68,424	45,983	2,466,227	1923
759,075	766,957	71,167	3,421	30,850	72,001	48,988	2,423,814	1924
744,691	753,017	72,121	3,791	30,481	70,918	47,877	2,430,636	1925
734,359	742,955	73,357	4,100	29,933	71,344	46,452	2,405,241	1926
757,020	765,331	77,614	3,909	31,141	77,219	49,202	2,442,754	1927
739,520	747,444	73,816	4,017	30,301	73,267	48,063	2,384,104	1928
805,962	814,545	83,224	4,553	32,023	74,538	50,438	2,628,203	1929
710,850	718,807	71,682	3,876	29,616	71,790	46,939	2,319,285	1930
725,816	734,165	77,048	3,971	30,674	77,121	49,414	2,420,440	1931
699,620	707,642	73,059	3,949	30,102	71,427	49,911	2,359,395	1932
730,802	739,180	72,093	3,724	29,168	69,579	47,181	2,392,350	1933

1919—refer to the territory of the respective period. The data for France (2), Germany (2), and Total (2) refer to ceded to Belgium and Denmark through the Treaty of Versailles.

estimated officially for Belgium at 115,000, for England and Wales at 577,000, for Scotland at 74,000, for Northern at 1,000,000.

1911–1914 and 1915–1919: 3,326 and 4,210 respectively for the small territories ceded to Belgium and Denmark,

1871–1933.

Latvia	Lithuania	Poland	Portugal	Rumania	Russia (Europe)	Spain	Yugoslavia	Australia	New Zealand	Years
—	—	—	—	144,979[2]	2,490,178	—	44,119	27,825	3,854	1871–75
—	—	—	—	140,727	2,573,300	509,038[3]	53,272	32,475	5,051	1876–80
—	—	—	—	125,498	2,805,583	558,040	45,484	38,554	5,815	1881–85
—	—	—	—	148,567	2,860,639	544,043	53,704	43,445	5,949	1886–90
—	—	—	—	170,195	3,199,260	543,218	64,960	44,307	6,705	1891–95
—	—	—	—	160,882	3,052,789	529,595	59,904	46,349	7,030	1896–00
—	—	—	—	160,885	3,216,932	490,902	58,563	45,757	8,137	1901–05
—	—	—	—	175,960	3,334,669	470,956	68,608	45,165	9,209	1906–10
—	—	—	119,383[5]	179,833	3,286,924	448,128	—	50,889	9,754	1911–14
—	43,521	711,493[7]	157,564	193,574[6]	—	507,677	—	54,237	11,652	1915–19
—	44,487	720,833	142,862	414,629	—	494,540	250,090	56,289	12,109	1920
—	31,915	568,329	126,316	372,157	—	455,469	252,104	54,076	10,682	1921
27,553	37,598	554,645	125,747	376,236	—	441,330	254,478	51,311	10,977	1922
26,080	32,432	493,835	141,775	372,480	—	449,683	252,543	56,236	11,511	1923
28,399	35,493	519,174	126,052	382,915	—	430,590	254,527	54,980	10,767	1924
27,683	37,179	492,248	117,413	361,995	2,233,402	432,400	239,429	54,568	11,026	1925
27,557	34,380	532,769	128,335	372,948	2,259,249	420,838	244,761	56,952	11,819	1926
28,941	38,897	525,653	123,332	392,850	2,410,592	419,816	276,294	58,282	11,613	1927
27,299	35,698	504,207	124,088	351,726	(2,153,000)	413,002	272,606	59,378	11,811	1928
28,512	39,669	518,929	118,824	377,646	(2,373,000)	407,486	286,249	60,857	12,314	1929
27,110	37,151	488,417	116,352	346,714	—	394,488	261,487	55,331	12,199	1930
26,891	37,478	494,893	115,225	378,507	—	408,611	276,827	56,560	12,047	1931
26,342	36,577	487,125	118,895	399,346	—	388,900	271,976	56,757	11,683	1932
26,319	32,749	466,210	120,996	348,085	—	394,682	—	59,117	11,701	1933

refer to the territory of the respective period. All data for Austria (2), Czechoslovakia, and Hungary (2) refer to the

[5] 1912–1914 only. [6] 1915 only. [7] 1919 only.

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THE END

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